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D. James Taylor

ELECTRICITY

IN

DISEASES OF THE EYE, EAR, NOSE AND THROAT

WITH ILLUSTRATIONS

BY

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CONTENTS

PART I. PHYSICS OF ELECTRICITY.

Page.
Chapter I. Elementary Physics of Electricity 1
II. Electro-Therapeutic Apparatus 49
III. The Author's Equipment 81

PART II. THE THERAPEUTIC USE OF ELECTRICITY AND THE TECHNIC OF ITS APPLICATION.

Chapter I. Electric Currents 87
II. Phototherapy 127
III. The X-Ray 145
IV. Ozone 179
V. Special Articles 185

PART III. ELECTRICITY IN DISEASES OF THE EYE.

Chapter I. Eyelids, Conjunctiva, Lachrymal Apparatus 197
II. Cornea and Sclera 229
III. Iris, Ciliary Body and Choroid 255
IV. The Crystalline Lens 265
V. The Vitreous 275
VI. Diagnosis of Foreign Body in the Eye and Magnet Operations 283
VII. Diseases of the Retina 297
VIII. The Optic Nerve 312
IX. Glaucoma 329
X. Ocular Manifestations of Arterio-Sclerosis 334
XI. The Ocular Muscles 339
XII. Ocular Headache 347
XIII. Congenital and Strabismic Amblyopia 353
XIV. Errors of Refraction 363
XV. Malignant Diseases of the Eye 368
XVI. Electricity An Aid in the Diagnosis of Eye Disease 382
XVII. High-Frequency and X-Ray in the Treatment of the Eye 385
XVIII. Personal Communications 396

PART IV. ELECTRICITY IN DISEASES OF THE EAR.

Chapter 1. The External and Middle Ear 402
II. The Mastoid 436
III. The Labyrinth 452
IV. Growths in the Ear 454

CONTENTS—CONCLUDED.

PART V. ELECTRICITY IN DISEASES OF THE NOSE.

Chapter I. Some Nasal Affections 457
II. The Turbinates 467
III. The Nasal Septum 486
IV. Nasal Growths 497
V. High-Frequency High Potential Currents in Diseases of the Nose and Throat 506
VI. The Accessory Sinuses 509

PART VI. ELECTRICITY IN DISEASES OF THE THROAT.

Chapter I. The Tonsils 516
II. The Pharynx 523
III. The Larynx, Trachea and Bronchi 534
IV. Exophthalmic Goitre 552
V. Personal Communications 564
Report of Some Cases under Electrical Treatment in the Author's Office during the Past Month 577

PREFACE.

While electricity is now a recognized modality in the treatment of diseases and few medical offices are without some electrical equipment, it is also true that knowledge regarding its nature and application is by no means widely diffused. Literature on the subject is comparatively scarce; in fact, with most practising physicians, electricity is in the experimental stage.

It is on this account that the author has felt unusual satisfaction in the preparation of the present volume. Having for years investigated the subject by a study of its literature, by experimentation in physics, and by its clinical application, and being convinced that electricity is, to a considerable extent, destined to supplant both surgery and treatment by drugs, it is both a pleasure and satisfaction to incorporate in the present volume the results of his own investigations and practice and also to gather into one compact whole the testimony of co-workers in this field. The best thought of electro-therapeutists, to date, on the application of electricity in diseases of the eye, ear, nose and throat, is what the author offers in the present volume.

The book is eminently practical. What has been accomplished and exactly *how,* is what it tells. Cases, giving conditions, methods and results, illustrate the writer's claim for electricity.

Electricity is a wide subject. It is applicable in many forms, and each current and other modality has its individual characteristics.

It is the author's earnest hope that the opening chapter on The Physics of Electricity will be studied by his readers. His own experience has been that books on the physics of electricity contain too largely the higher mathematics, while those on medical electricity too often are meagre in electrical principles. It has been his aim to offer fellow-students such elementary physics as are essential for the intelligent use of electricity, and couched in language that is intelligible to all.

Part Three treats of the therapeutic use of each and every electrical modality; while the balance of the book illustrates the various modalities in use, with history of cases and results.

The author acknowledges gratefully the value of Leprince's work, entitled "Precis D'Electrotherapie et de Radiotherapie Oculaires." It brought to him much of the work accomplished by continental electro-therapeutists, whose achievements are not on record in our own journals. In fact, it is the only book, as yet published, treating of electricity in diseases of the eye.

To W. Scheppegrell, of New Orleans, tribute is also due. His work on "Electricity in Diseases of the Nose, Throat and Ear" has been invaluable. Pusey-Caldwell, among the pioneers in X-ray, have kindly permitted extensive quotation.

To the many other writers, whose articles have been freely drawn upon, and to whom full credit is accorded in the Bibliography, the author extends cordial acknowledgement.

Comparatively brief space has been devoted to electrical apparatus. The author considers that the prime requisite is an understanding of electrical principles; of the various electrical modalities; and their precise application to diseased conditions. Enough has been said regarding electrical appliances and apparatus to enable physicians to make wise selection from the large and varied stock of the many excellent electrical firms of the country.

W. Franklin Coleman.

Chicago, November, 1912.

To my friend
A. M. ROSEBURGH, M. D.,
Toronto, Canada,
a pioneer in
Electro-Physics
and
Electro-Therapeutics.

CHAPTER I.

ELEMENTARY PHYSICS OF ELECTRICITY.

The prevailing statement that we do not know the nature of electricity, too often, I fear, embodies it as a spectral form, which we can neither handle or comprehend; whereas, it is no more mysterious than other physical forces, which are only comprehended by their phenomena. In fact, electrical phenomena are more capable of exact computation than are those of the allied energies heat and light. Physicists, at present, agree that heat, light, and electricity depend, relatively, upon different rates and forms of vibration of the universal ether,—heat representing the least frequent rate and, electricity, the most frequent of the three.

While it is now known that the rubbing of any two substances together produces electricity, apparently, the first hint of the science and uses of electricity was accidentally given to Thales of Greece, (*640-560* B. C.) when he noticed that rubbed amber (*elektron,* amber) would attract and repel certain bodies. Time will not allow of more than an allusion to such alluring names in the development of electrical science as Thales, Gilbert, Franklin, Lord Kelvin, Clerk Maxwell, S. S. Thompson, Tesla and numerous others; and to the wizard inventive applications of Edison.

Fundamentally, all forms of electricity are the same. The effect of the current varies according to the apparatus employed and the method by which the current is produced. These differences show themselves in the relation of the voltage to the amperage and in the amount of these; in the direction of the current, whether in a direct course as in the direct, galvanic, or continuous; or, in reverse directions, as in the alternating or sinusoidal; whether it is a primary current, or one *induced* by a primary or a static charge. Further, the frequency of the interruption of the current modifies very much its therapeutic effect.

I will treat briefly not only of the electrical energies used directly in medicine, such as the galvanic, faradic, alternating, high-frequency and static, but also of the *indirect* use of electricity by means of the *x*-ray, electric motors, massage, cautery and lamps.

FRICTIONAL OR STATIC ELECTRICITY.

Franklin's theory of frictional electricity, now slightly modified, was that all bodies possess a certain amount of electricity and that friction produces, by separation, two dissimilar, simultaneous, electrical states, which he called positive and negative; and, that if various bodies be rubbed, some will be charged with positive and others with negative electricity; and, in all cases, the rubber is charged equally with and oppositely to the body rubbed.

Further, if these objects are non-conductors, as glass, etc., the charge will remain on their surfaces.

Bodies, which conduct electricity, as metals, may be electrified if they are insulated by a non-conductor such as ebonite, etc.

A glass ignition rod, rubbed with flannel, is charged with positive electricity, the flannel taking a negative charge; while a rod of sealing wax rubbed with flannel is negatively electrified, the flannel becoming positively electrified.

The rubbed glass rod, held near bits of paper, as in Fig. *1*, induces a negative charge in the bits and attracts them to itself, when they are given a positive charge and repelled.

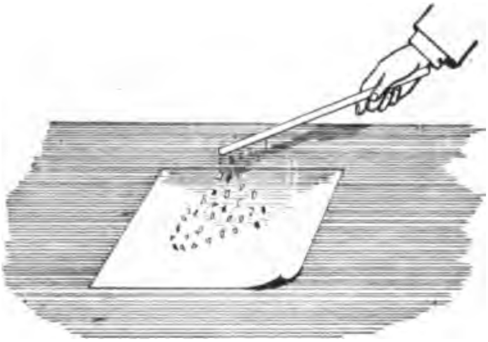


Fig. 1.

The negative wax rod would electrify the papers positively, attract them, then give them a negative charge and repel them.

That is to say, oppositely charged bodies attract and similarly charged bodies repel each other.

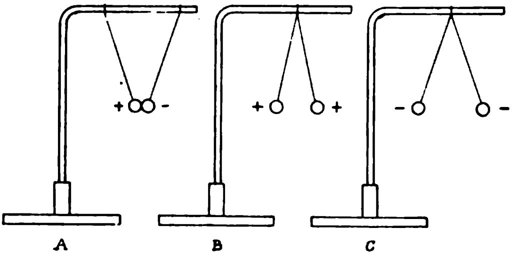


Fig. 2.

If, in Fig. 2, A, two pith balls be suspended by non-conducting silk threads and charged + and —, by bringing in contact with the left one an electrified *glass* rod, and, with the right one, an electrified *wax* rod, the two balls will attract each other.

In B. and C. the balls repel each other, when both are charged respectively + and —.

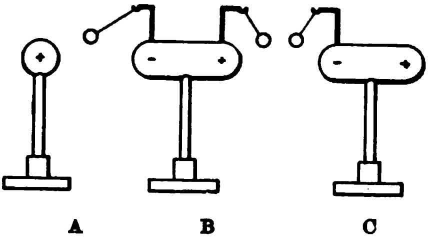


Fig. 3.

In Figure *3*, let A. represent a charged glass ball, insulated; and B. C. two oval neutral metallic bodies on insulated stands, and supporting pith balls.

If A. be placed near B. it will repel a + charge to the far end of B., and attract a negative to the near end.

If C. be brought near to B. the latter will induce in C. the charges indicated.

Imagine in Fig. *3*, B. the end + to be grounded, by connecting it with the earth, by a metal conductor: the positive charge will then escape to the earth. If then the earth connection is disconnected, the — charge on B will be bound by the + of A. Should now, A. be removed, the — charge of B. would distribute itself over the whole surface of B.

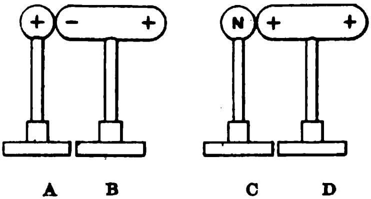


Fig. 4.

Figure *4* represents first the effect of bringing a body A. charged + *near* to an uncharged body B., when by induction, it is electrified — and +. Secondly, when the body A. is brought *into contact* with B., the result is shown in C. D.: that is, by *conduction,* the — of B. flows to A., and is neutralized; leaving the B charged + +, as shown in D.; while A. returns to a state of equilibrium, as shown in N.

The above assumes that the + charge in A. is just sufficient to neutralize the — in B. If A. contains a greater charge, then it gives a still greater charge to B. than in the previous case. That is to say, a positively charged body, brought into contact with an uncharged one, gives it, by conduction, a positive charge. The surface density of a charge is not distributed uniformly over the surface of a body except in the case of a sphere.

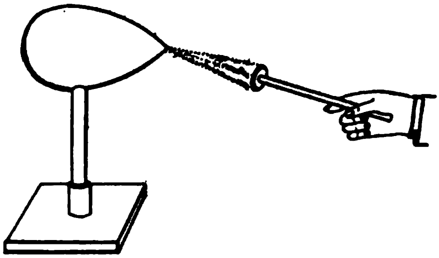


Fig. 5.

Figure *5* illustrates the charge to be of greatest density at the point of the cone, and that the limit of electrification has been reached when a discharge occurs.

THE ELECTROPHORUS.

The Electrophorus is not only a *generator* of electricity but also a carrier.

Suppose the lower part of the figure to consist of a sheet of ebonite grounded and the upper part a sheet of tin, attached to a non-conducting handle of

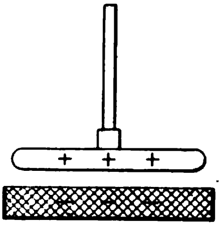


Fig. 6.

ebonite or glass. To demonstrate its use, give to the ebonite sheet a — charge, by rubbing it with a cat's skin. Take the metal cover by the handle and place it on the ebonite sheet. The under side of the metal sheet will be charged + and upper —. Touch the upper — part of the plate with the fingers and the negative charge will be neutralized by a positive current flowing from the earth through the body and hand. This will leave the + charge on the metal sheet, being bound by the attraction of the negative on the ebonite. If the cover is now lifted, the + charge is freed from the influence of the ebonite and distributes itself over the whole surface. If the cover is now touched by the finger, positive sparks appear.

The above action of the electrophorus shows that if an insulated conductor be touched while it is under the influence of a charged body, the conductor acquires a charge opposite to that of the influencing body.

STATIC ELECTRIC MACHINES.

A Static Machine is an electrophorus of increased efficiency; and, like it, consists of two parts, one for producing electric charges—as does the ebonite sheet—and the other for collecting them—as does the cover. The quantity of charge depends upon the amount of friction and the extent and nature of the surfaces rubbed.

The Static Machine illustrates the principle stated: that if a conductor is touched, while charged by induction or influence, it acquires a charge opposite to that of the influencing charge. It also illustrates reciprocal accumulation.

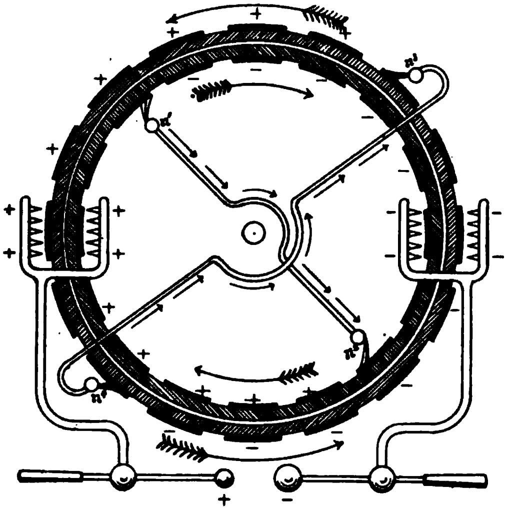


Fig. 7.

To explain the action of the Static Machine, I have copied the excellent cut in Silvanus Thompson's book, "Elementary Lessons in Electricity and Magnetism."

Imagine three insulated conductors, which we will call A., B., and C; A. and B. being charged respectively + and —; C., a *carrier*, which moves to A. and receives + charge. If *touched*, while it is under the influence of A., it will receive a — charge and can carry it to B. If again touched, it acquires a + charge. Let it return to A. and give up its + charge. Thus the influenced carrier transports its charge and adds it to the influencing charges, by which there is reciprocal accumulation of charge.

Instead of revolving plates, the diagram, Figure 7, represents an inner and an outer cylinder; the former revolving from left to right, and the latter from right to left. The sectors of metal foil, cemented to the front of the front plate and to the back of the back plate, are indicated by + and —. They are *carriers* and *inductors* of electricity.

Across the front and back are uninsulated conductors, n_1, n_2, n_3 n_4, terminating in neutralizing metal brushes, which touch the front and back sectors as they pass. Two pairs of insulated combs, which serve as collectors, are furnished with a pair of discharging knobs and are connected with Leyden jars, which serve as accumulators. The brushes n_1, n_2, touch the front sectors; the n_3, n_4, the back.

The action of the machine may perhaps be most readily understood by remembering that the opposite sectors on the two plates act inductively upon each other; and that a conductor, in contact with the influenced sector, carries off the free charge of the same sign as the influencing sector and leaves the charged sector of the opposite sign: e. g. + gives a — charge and — gives a + charge. Again, a current always flows through the conductor from the higher potential to the lower or neutral potential.

Suppose, in the machine, some sector, as the one on the outer plate, opposite n_1, to have a very slight + potential or charge. This initial charge is probably obtained by the friction between the machine in motion and the air.

Let the initial potential of the outer sector, opposite n_1, be +. By induction, it gives a — charge to the outer surface of the opposite inner sector and an equal + charge to its inner surface. The conductor carrries this + charge from n_1, to the sector n_2, leaving the — charge to be carried by each inner sector, as it passes n_1, till it reaches n_3, and the collecting — comb. At the same time, the inner sectors, passing n_2, to the left till they reach n_4, and the collecting + comb. Again, the + charges of the inner sectors induce + charges on the outer sectors, which are carried by n_4 to n_3; leaving the — to be carried to n_2 and the — combs, while the n_4 brush carries + charges to n_3, which move to the left to the + combs.

Again, n_1 n_2 carries the induced + charge at n_1 to n_2 and the inner sectors collect it and carry it to the + combs; and, opposite n_4, induce a + charge which is carried to n_3; then the outer sectors carry it to the + combs. At n_4, the bound — charge is carried by the outer sectors to the — comb; and at n_1 the free — charge is carried by the inner sectors to the — comb.

While this induction and conduction of charge is going on between the moving sectors when opposite the conductors, there is also a great addition to their charges by mutual induction of + and — charges between the sectors, not opposite the conductors.

Evidently the upper outer sectors and the lower inner sectors carry + charges to the combs; while the inner upper and lower outer carry — charges to the opposite combs. It is understood that "inner" in the diagram is the outer surface of the front plate. The charges of the plates increase until the gain is arrested by the loss due to dissipation and leakage.

A machine with twelve plates, thirty inches in diameter, at a speed of two hundred turns a minute, gives a twelve inch spark between the prime conductors and the enormous potential of two hundred and fifty thousand volts, while the quantity of current is only *.01* m. a. So great is the electro-motive force of frictional electricity, that, by rubbing an ebonite rod with a cat's skin, I have demonstrated a voltage of one thousand by means of an astatic voltmeter.

The resistance of the plates of a Holtz machine, at four hundred and fifty revolutions per minute, has been found to be six hundred and forty-six million ohms. This, with two hundred and fifty thousand volts would give only *.4* m. a.

MAGNETISM.

The word *magnetism* takes its origin from Magnesia, a district in Asia Minor, where loadstone, a magnetic oxide of iron, was first found.

If iron filings are scattered over a piece of paper, which is held over a natural or electro-magnetic bar magnet, they will tend to arrange themselves in curved lines around the magnet. See figure *8*.

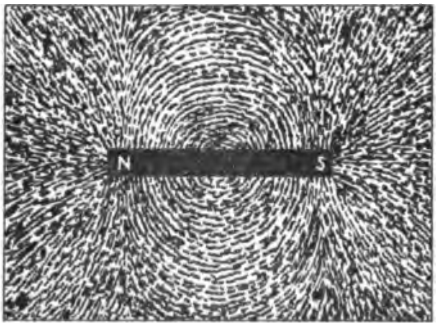


Fig. 8.

These visible lines must represent invisible lines of force.

When the opposite poles, N. and S. of two magnets are held near each other, the filings, or lines of fore, tend to coalesce. See Figure *9*.

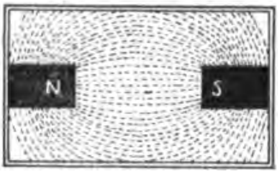


Fig. 9.

With like poles, N. and N. or S. and S. the filings tend to repel each other. See Figure *10*.

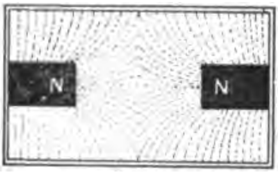


Fig. 10.

That is to say,—Unlike poles of a magnet attract, and like poles repel each other.

Magnetic lines of force have the distinguishing characteristic of moving in curved lines, while electrical energy moves in a straight line.

In the use of the eye magnet, it is essential to remember that only iron can be magnetized. The magnetizable elements are called paramagnetic, (para, beside; magnes, a magnet). If a magnetizable body is placed near the positive pole of a magnet, it will be magnetized by induction with a negative polarity: if placed in the field of the magnet, near its negative pole, it will receive a positive polarity.

Bodies which cannot be magnetized are called diamagnetic, (dia, through; magnes, a magnet) — as, notably, antimony, copper and gold, which, placed in a magnetic field, try to direct themselves east and west across the earth's magnetic lines; that is, they tend to assume a position at right angles to the exciting magnet.

A small magnetizable body, placed near a magnet of any strength, is fully saturated with magnetism, and the magnet attracts it with the same force that the body attracts the magnet. For bodies situated in the vitreous, a giant magnet is necessary. A small magnet might suffice, provided it could come in contact with the foreign body; but, stirring up the vitreous with the tip of the magnet in the hope of a pleasant meeting with the foreign body usually results disastrously.

All magnets magnetized with a magnet or by an electric current have at least two poles. The polarity of a bar magnet can be readily ascertained by presenting one end near a magnetic needle. If the bar attracts the north end of the needle, it shows that it is the south end of the bar; if it repels the needle, it is the north end of the bar.

Induction of Magnetism. As in static electricity, a charged body first *induces a charge* in a neutral body and then attracts it, so a magnet, held near an unmagnetized body, first induces magnetism in it and then attracts the body; and this magnetic attraction will take place across all substances that are not magnetic. Soft iron is readily magnetized and soon parts with its magnetism; while hard steel is magnetized with difficulty but remains a *permanent* magnet.

The Electric Magnet. For therapeutic use, the electro-magnet is made by passing a direct current through a coil of wire wound around a soft core, in which case, the core parts with its magnetism as soon as the current is turned off.

Powerful magnets are made by winding a coil around each arm of a horseshoe-shaped core of soft iron, across the ends or poles of which is placed a keeper or armature.

Magnetic Field. In a bar magnet, curved lines of force pass through the bar, and from the north to the south pole of the bar through the air, in a space called the field of the magnet. Around every conductor carrying an electric current, there are magnetic lines of force which encircle the conductor at right angles.

Theory of Magnetism. When a magnet approaches a magnetizable body, the particles of the latter are magnetized and are thereby turned endwise in one direction.

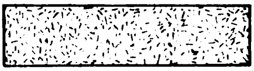


Fig. 11.

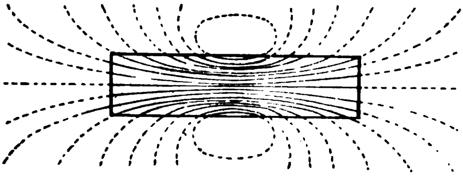


Fig. 12.

In a glass tube, Figure *11*, filled with iron filings and stroked from end to end with one pole of a magnet the filings will arrange themselves endwise and the tube will act as a magnet. The filings may be demagnetized by shaking the tube and deranging the filings. Completely magnetized particles will then arrange themselves along the line of force, as shown in Figure *12*.

GALVANISM.

The galvanic or direct current for medical use is, usually, supplied by a direct current dynamo for street lighting. It may be supplied by the chemical action of battery cells. Where available, the street current is the most satisfactory, as it is the most convenient and most uniform; the voltage being kept unchangeable at the power-house, and, generally, at *110* to *220* volts.

Notwithstanding its almost universal use by physicians—any adverse result to the patient is extremely rare. When, on the contrary, the street lighting is produced by an alternating current dynamo, it may be transformed, for medical use, into a direct current by means of a so called rectifier.

BATTERIES.

In a chemical battery, the plates or elements should differ as much as practicable in their capacity of being acted upon by the battery fluid: hence carbon, which is not attacked, and zinc, which is readily acted upon, are generally used.

The current is said to "flow," or better, to be transmitted from the source of its production, as from the zinc plate or from the dynamo, around the circuit to its source.

This may be illustrated by a cell, e. g. a glass tumbler, a zinc and a carbon strip, dilute sulphuric acid, copper wire, and a galvanometer. See Figure *13*.

The chemical affinity, which is electrical, of the acid for the zinc produces zinc sulphate and an energy called *voltage*, a force which overcomes the resistance of the circuit and produces or tends to produce a current. Within the fluid, the zinc is the positive pole and the carbon the negative. Outside the fluid, the carbon becomes the positive pole and the zinc the negative; since, in the circuit, the current flows within from the zinc to the carbon; and, outside, it flows from the carbon to the zinc.

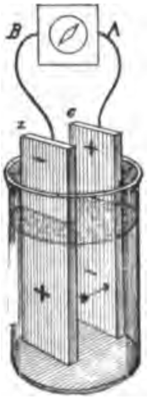


Fig. 13.

In Fig. *13*, the positive terminal A, connected, by the wire, with the carbon (+) plate, is called the positive pole, electrode or anode, (ana = from, odos = way), as the current proceeds *from* the anode.

The negative (—) terminal B, connected with the zinc (—) plate is the negative pole, electrode or cathode, (cata = toward, odos = way), as the current proceeds toward the cathode.

The needle of the meter indicates the existence of a current, its direction and amount.

THE FACTORS WHICH ENTER INTO THE PRODUCTION OF A CURRENT.

When these factors are fully comprehended, the greater part of the physics of electricity is mastered. It is not easy to define in exact language the nature of these factors, and the conventional terms used seem, too often, inaccurate and confusing.

The factors are known as *voltage*, (electro-motive force, pressure or tension), *resistance* and *current.*

Voltage is the force or energy, produced by chemical or physical means, which generates, or tends to generate, a current of electricity by forcing it through a resistance.

Resistance is obstruction to transmission.

The current signifies electricity in motion. The conventional word "flow" of a current is convenient; but electricity does not literally flow (except in liquids) any more than does heat, which is transmitted along a conductor, to the distant end. So a dynamic condition of an electric conductor is transmitted through its length.

These terms may be better understood by applying them to hydrostatics and heat. A water reservoir, a discharge pipe, and a receiving vessel will serve as an illustration. The pressure of the water is directly proportional to the height above the receiving vessel. This pressure is analogous to electric pressure or *voltage,* and, other things being equal, the amount of the flow of the current of water or electricity depends upon the pressure.

Again, the degree of resistance to the flow of the water is relative to the size of the pipe—being inversely to the square of its diameter. Just so, the resistance to the flow of an electric current, through a conductor, is inversely to the square of its diameter. A cord of *.1* inch diameter has four times the resistance of a cord *.2* diameter: hence the former conducts one quarter the amount of current. With a given pipe, the *force* of the water delivered to the receiving vessel is the same at any instant of time and is equal to the pressure divided by the resistance; while, the *amount* of water delivered is equal to the force multiplied by the time of flow. Similarly, the force or *energy* of a current is the same at any instant; but the amount of the current is the *force* multiplied by the *time* of flow. The unit of this energy is one ampere. The *amount* of the current is one ampere multiplied by one second, which equals one *coulomb.*

The electric units of *pressure, resistance* and *current* are respectively *volt, ohm* and *ampere.* In terms of the factors, or, to talk in a circle, a volt is the electro-motive force required, against a resistance of one *ohm,* to produce a current of one *ampere.* An *ohm* is the resistance required, against an electro-motive force of one *volt,* to produce a current of one *ampere.* An *ampere* is produced by the electro-motive force of one *volt* against a resistance of one *ohm.* The electro-motive force produced by one Daniell cell is *1.14* volts.

An *ohm* may be represented by the resistance of a copper wire, two hundred and fifty feet long and one twentieth of an inch in diameter. The amperage is not the rate of flow or quantity or volume of the current, as is frequently stated. It may be defined as the amount of energy which the magnetic field of the current shows in attracting a needle.

The amount, volume, quantity or rate of flow of the current is represented by the amperage multiplied by the time: that is—one ampere, multiplied by one second, equals one coulomb.

Difference of Potential.—If a different potential or voltage be applied to each end of a conductor, as to the prime conductors of a coil, the direction of the current will be towards the lesser potential and its energy will be the difference between the potentials.

Figure *14* may illustrate this. Let the pressure of the water in the tube, between A. and B. be *100* and between C. and B. be *30*, the flow will be *70* and from C.

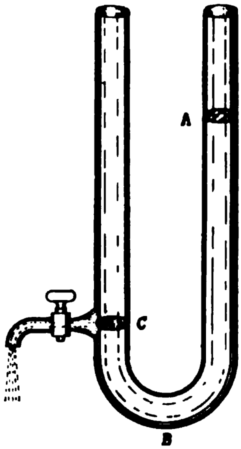


Fig. 14.

The law which governs these three factors is called Ohm's Law, and is as follows: The *electromotive force* divided by the *resistance* is equal to the *current* or intensity; or, using the units of these factors, one *volt* divided by one *ohm* equals one *ampere*. That is, the current varies directly as does the voltage and inversely as does the resistance. Or, in other words, the resistance remaining constant, the current increases or diminishes, as the voltage increases or diminishes: or again, with the voltage remaining the same, the current is increased by diminishing the resistance or decreased by increasing the resistance.

Having the volts and the ohms, the amperes are estimated by dividing the volts by the ohms. Having the volts and the amperes, the ohms may be determined by dividing the volts by the amperes. Having the ohms and the amperes, the volts may be determined by multiplying the ohms by the amperes.

As an aid to swift calculation, I offer the following method:—Let the volts, ohms and amperes be represented by the numbers, respectively, *8*, *4*, *2*. Having *8* and *4*, the unknown is determined by dividing *8* by *4*. Having *8* and *2*, the unknown is determined by dividing *8* by *2*. Having *4* and *2*, the unknown number is determined by multiplying *4* by *2*. This rule is invariable in the determination of the unknown volts, ohms or amperes, when any two of these factors are known.

For medical use, an ampere represents too strong a current hence medical meters indicate a thousandth of an ampere, or a *milliampere,* which is briefly written *m. a.*

What do the Dynamo and Battery supply? In answer to the oft repeated question of the physician, "How much current will a given battery furnish?" Neither the battery nor the dynamo supplies current. They produce voltage, from which current is derived. The current they are capable of producing with a given voltage depends upon the amount of resistance used in the circuit. If there were no external resistance, as of the body, the voltage of one cell would produce as much current as that of a hundred cells of the same voltage connected *in series.* By series, is meant, that each carbon of a cell in the battery is connected with the zinc of its nearest neighbor, and, to complete the circuit, the last carbon is connected with the first zinc. See Fig. *15.*

The Effect Produced upon Voltage and Amperage by Joining Cells in Series, Parallel and Multiple Parallel.

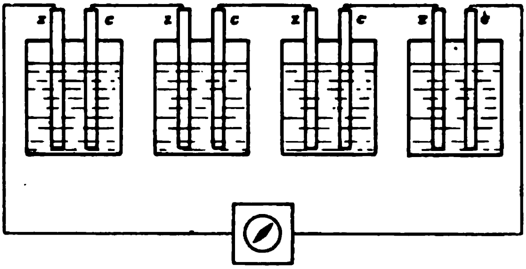


Fig. 15.

Cells Joined In Series: Assuming a pressure of one volt and an internal resistance of *1/4* ohm in each cell:

One cell=$\frac{1 \text{ Volt}}{.25 \text{ ohm}}$ =*4* A. Four Cells=$\frac{4 \text{ volts}}{1 \text{ ohm}}$ =*4* A.

Cells Joined In Parallel. Joining four cells in parallel, as in Fig. *16*, has the same effect as if all the elements of zinc and carbon were placed in one large cell, having four times the cubic capacity of the small one; and joining all the zincs together and all the carbons together is equivalent to increasing their size four times.

The difference of potential in the two large plates is the same as that between the two small plates. In the large cell, the *sectional area* of the fluid and plates is increased four times, therefore the ***resistance*** is ***reduced*** to one quarter that in the small cell; then *1/4* ÷ *4* = *1/16* ohm. Hence the amperage is = $\frac{1 \text{ volt}}{1/16 \text{ ohm}}$ =*16* amp.

This combination gives high amperage for cautery purposes.

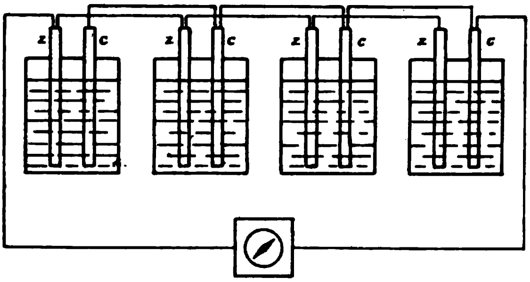


Fig. 16.

Parallel Series Connection.—See Figure *17.*

Each pair of cells has an electro-motor force of one volt. Two pairs of cells have one volt multiplied by two, equalling two volts. Each pair has also half the resistance of one cell, that is, $1/4 \div 2 = 1/8$ ohm and the two pairs have $1/8$ ohm $\times\ 2 = 1/4$ ohm.

The amperage in this combination is $= \frac{2 \text{ volts}}{\frac{1}{4} \text{ ohm}} = 8$ Amp.

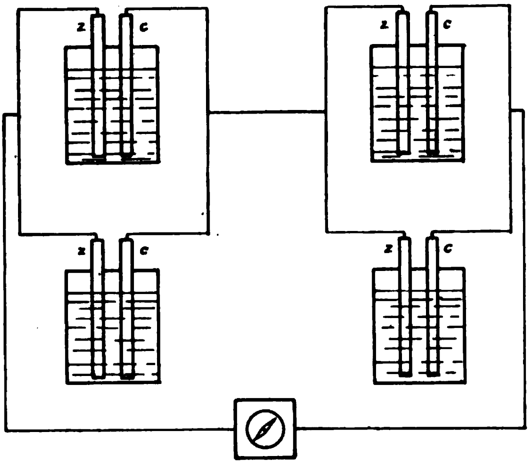


Fig. 17.

It will be noted that the wattage is the same in the series, parallel and multiple connections of the cells:

1. 4 Volts × 4 Amp. = 16 Watts.
2. 1 Volt × 16 Amp. = 16 Watts.
3. 2 Volts × 8 Amp. = 16 Watts.

When an external resistance, such as that of a patient, is placed in the circuit, the m. a. will be increased nearly in proportion to the increase in the number of cells used.

Suppose the patient has a resistance of 5000 ohms, and the cell a resistance of 1/4 ohm.

With one cell, the current is $\frac{1 \text{ volt}}{5000.25 \text{ ohms}} = \frac{1}{5000}$ A nearly. With four cells, the current is $\frac{4 \text{ volts}}{5001 \text{ ohms}}$ $= \frac{1}{1250}$ Amperes, nearly.

The internal resistance of the cell is so small that it adds little to the external resistance. As in the above case, one cell adds 1/4 ohm to the 5000, and four cells add only one ohm; but the voltage is increased four times and thus yields nearly four times the current of one cell.

Conduction of a Current.—Resistance to a current might as well be expressed in terms of conduction. A good conductor has a low resistance and a poor conductor a high resistance. Among the metals which are good conductors, silver and copper stand at the head of the list. Copper is used in making electric coils, conducting cords and electrodes as it is cheaper than silver and has nearly an equal conducting capacity.

The relative capacity of the metals for electric conduction very closely corresponds with their capacity for the transmission of heat.

The Means of Measuring a Direct Current With a Galvanometer.—When any electric current passes through a conductor, it sets up a magnetic or an electric field consisting of lines of force which surround the conductor and cut it at right angles. If an iron or steel needle be placed parallel to the conductor, it will be magnetized and tend to place itself in line with the lines of force at right angles to the conductor: the end of the needle, moving away from the direction of the current in the conductor, being made the North pole and the end moving towards the conductor the South pole.

In Figure *18*, C. and D. represent the binding posts, into which are inserted the cords which conduct the current.

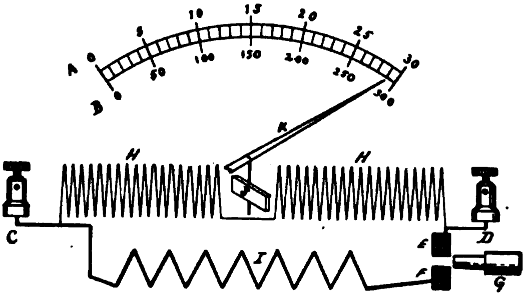


Fig. 18.

If the positive cord is connected with C., and the negative with D., the current will pass through the coils at H. H. to the post D. (negative), magnetizing the needle J. moving it, and, with it the pointer K. to the right along the scale from *0.* to *30.* A permanent magnet maintains the pointer K. of the needle J. at zero and acts as a counteracting force to the strength of the magnetic field of the coils H. H. —the strength of the current, that is of its magnetic field, being indicated by the pointer.

Usually, there are two scales on the meter, one representing ten times the values of the other. The higher values are secured by shunting the current, that would otherwise pass through the meter, through a resistance coil through which nine tenths of the current passes and allows only one-tenth to pass through the meter.

In Figure *18*, insert the plug G. to connect E. and F. Then suppose the combined resistance of the coils H. H. and I. to be one ohm, of which H. H. has *9/10* and I., *1/10*. The current that passes through each coil from C. to D. will be in reverse ratio to the resistance; one-tenth of the whole current passing through H. H. The patient connected at C. and D. receives the whole current carried by the two coils, which is ten times as much as passes through the meter. The current which passes through the patient is registered on the lower scale, which runs from *0* to *300* m. a.

Meters of recent make are, in general, nearly accurate, but it is best to test one before measuring such small doses as are required in the treatment of the eye. The test can be made by connecting up the meter in series with a *standard* meter and comparing the result, which should not differ more than *.5* of a milliampere. Special meters can be purchased not registering over *100* m. a.— quite sufficient for our purpose. They are more accurate than those measuring a stronger current.

No operator should use a direct current without measuring it any more than a physician should administer an unmeasured drug; for, with the exception of the *x*-ray, there is no current so likely to be harmful, if used in excess, as the direct. On the other hand, there is no current that affords so wide a range of usefulness as the direct; but it must always be regulated by consideration of the pathological condition of the patient and his susceptibility.

GALVANOMETERS AND VOLTMETERS.

These two instruments are exactly alike in principle and differ only in the details of their construction and in their uses. In fact, the voltmeter is only a delicate galvanometer.

If the resistance is constant in the circuit, the galvanometer can be graduated to read both amperes and volts. For instance, through a resistance of *20* ohms, giving *1* ampere of current, the voltage is *20* ohms × *1* ampere = *20* volts.

Hence, every ampere or fraction thereof represents *20* volts or fraction thereof. But when the resistance is variable, it is impossible to graduate the instrument to represent the volts. If the ohmic resistance is not *20*, but, say *40*, and the amperage *1*, the voltage will be *40* instead of *20*: that is, for every ampere of current, the scale should read *40* volts—but it is graduated to read *20* volts.

The galvanometer is constructed with a short, thick wire, in order to offer a low internal resistance to the flow of the current. It is always connected up in series in the circuit and measures the current in any part of it.

A galvanometer, constructed with a long, thin wire, allows only a delicate current to pass through it, and, by the intensity of the current on its needle, measures on a scale, in volts, the pressure that produced the current.

Let the resistance of the meter be *1000* ohms. If a current of $\frac{1}{1000}$ of an ampere or *1* milliampere pass throught it, the voltage must be *1* volt: $\frac{1}{1000}$ ampere ×*1000* ohms = *1* volt.

The terminals of the meter are connected across the circuit and the same voltage passes through the meter as in the included portion of the main circuit; for, in a divided circuit, the voltage in a branch is the same as in the main circuit.

While it is well to explain the principle and application of a voltmeter, the physician has practically little use for it, as he is concerned only with the amount of the current, which he measures with the milliampermeter.

Current Controller or Rheostat.—(rheos = current, flow; istavia = to withstand.) Currents are controlled for medical use by a rheostat. Of these, there are two popular varieties; the graphite—least used; and the German silver coil.

The Graphite Rheostat is less durable than the coil and has the undesirable quality of being a better conductor when heated, thereby increasing the initial current and necessitating constant regulation of the current.

In the application of a definite amount of current, it is immaterial in what way it is controlled, whether by a rheostat or a current controller, so far as the amount of voltage, or the effect upon the patient is concerned.

The resistance of a given conductor to a current is inversely proportional to the area of the cross section of the conductor and directly proportional to its length; hence, the combined resistance of two conductors of equal area is one half of one of them. If any number of equal conductors be connected, separately or as one, with a source of voltage, they all receive the same amount of voltage but the current depends upon the resistance.

Let each of two conductors, having *1000* ohms resistance, be connected separately with a voltage of *100*,—then each delivers a current of $\frac{100 \text{ volts}}{1000 \text{ ohms}}$. $=1/10$ of an ampere; or, combined, $=1/5$ A.

If the conductors be joined in a parallel manner, they will have double the cross area of one and give the same current as before: i. e. $\frac{100 \text{ volts}}{500 \text{ ohms}} = 1/5$ A.

Coil Rheostat.—The principle of the usual coil rheostat used in series with the patient, is readily demonstrated in Figure *19*.

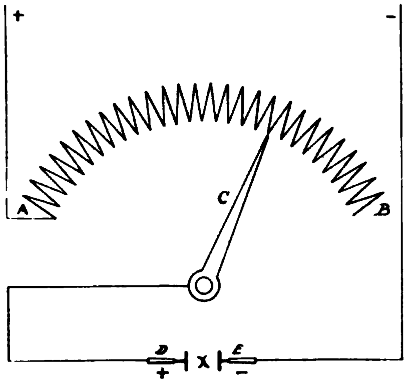


Fig. 19.

A series rheostat, in which the current that passes from + through A. to C. and through the patient X. by means of the electrodes D. and E. to the — supply wire, is controlled by the switch C. When the switch is placed at B., the resistance of the whole coil, added to that of the patient, allows only a very little current to pass. C. is moved towards A. to lessen the resistance in order to increase the current as required.

Current Controller.—See Figure *20*.

In the figure, the current divides at A. passes from A. to B. through the coil and through the shunt circuit; that is, from A. through the patient X. switch C. to B. There is the same drop in voltage in the coil between A. and C. as in the patient's circuit; hence, the nearer C. is to B. the greater the current through the patient.

The coil A. B. is graduated in volts, under the condition of its definite resistance, to show the drop in voltage from A. to B. When a patient is thrown into the shunt circuit, the resistance of A. B. is thereby lessened and the graduation is then not strictly accurate; but, on account of the high resistance of the patient, the instrument serves as a relative means of selecting the same indicated volts for a particular patient from day to day.

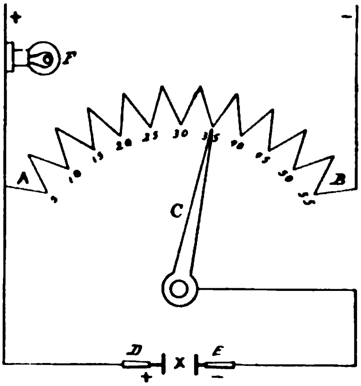


Fig. 20.

The Rheotome.—An Instrument for making and breaking either the direct or induced current.

The wall plate rheotome is a clock work arrangement, in which the speed is regulated by a pendulum or otherwise. The number of interruptions per minute varies with the speed of the clock and the number of brushes on a revolving cylinder which are made to come in contact with one of the three springs.

In Figure *21*, the current at C. passes through B. when the instrument is not in action. When B. is moved to *1*, *2*, or *3*, the current passes through the spring D., the revolving cylinder A. and its one, two or four brushes, as they are connected with *1*, *2*, or *3*.

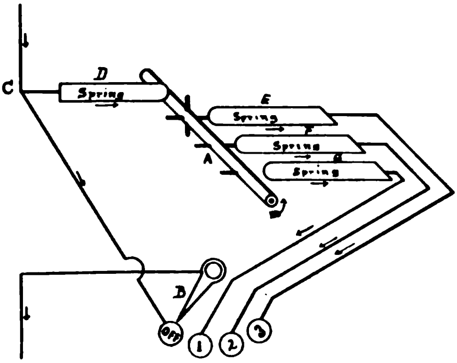


Fig. 21.

Resistance Box.—This is a usual type of instrument for measuring ohmic resistance. The principle of its action is shown in Figure 22½.

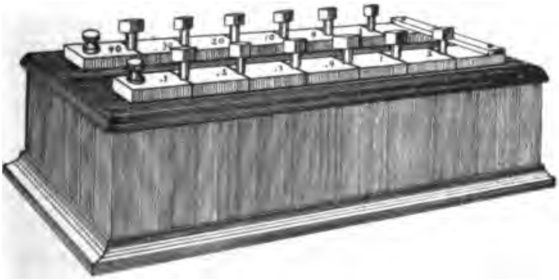


Fig. 22.—Resistance Box.

When the plug, between A. and B. or B. and C. is withdrawn the current must pass through the respective coil below the plug which has a definite resistance. When the plugs are in, their metallic resistance is so slight that the current readily passes through A. B. C.

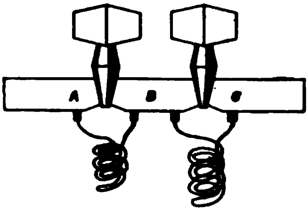


Figure 22½.

In Figure *22*, any amount of ohmic resistance desired can be obtained by withdrawing one or more plugs; for example, *40*, *1*, *2*, *3*—*43* ohms. The box may be used to determine the resistance of a patient by substituting the patient for the box. Suppose, with the patient in the circuit, the meter shows *5* m. a. of current. Substitute the box in the circuit, turn on the same voltage as previously and regulate the resistance in the box so that the meter reads *5* m. a. This resistance will be the same as that of the patient.

THE INDUCED OR FARADIC CURRENT.

This is the current produced by the small coil of the usual medical wall plate.

Faraday discovered, in *1831*, that by moving a magnet near a closed circuit, an *induced* current would be produced in it; and also, later, that this induced current could be produced in a closed circuit when a current in a neighboring closed circuit was varied in strength, by any means.

See Figure *23*.

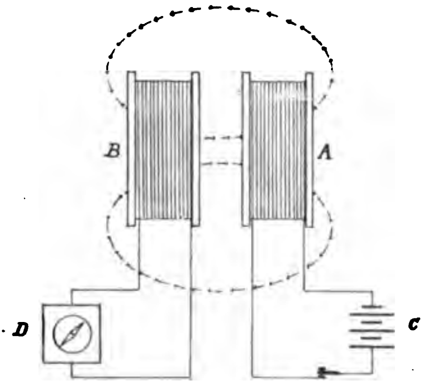


Fig. 23.

If the intensity of the current in one coil A., called the *primary* does not vary in strength, it will not excite an induced current in the coil B. near it. This intensity may be varied either by approaching or withdrawing either coil from the other or by making and breaking the circuit of the primary coil A. by means of the interrupter below C.

The closing and opening of the interrupter makes and breaks the current in A., producing magnetic lines of force, as shown by the arrowed rings which cut the coil B. at right angles and excite in it an *induced* current, that gives a to and fro movement to the index of the meter.

When the circuit is open, the gap is completed by air conduction, which has so high a resistance as to prevent the flow of the current, unless this is of very high intensity.

The Faraday Ring is an induction coil and the first transformer ever constructed. See Figure *24*.

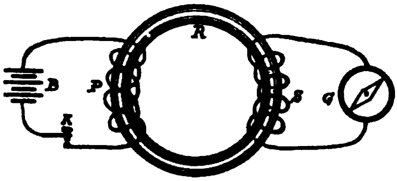


Fig. 24.

It consists of a ring of soft iron, around which insulated copper wire is wound, the two helices being separated by uncovered ring. The primary helix P. was connected with a battery B. and the secondary S. with a galvanometer. Upon making the current the galvanometer was immediately affected; but, though the contact was continued, the effect was not permanent, for the needle soon came to rest. Upon breaking the contact with the battery, the needle was again powerfully deflected, but in the contrary direction.

The principle of this ring is exactly that of the induction coil: and every induction coil is a transformer. The battery current produces in the coil P. magnetic lines which cut the loops at right angles, making them an electro-magnetic coil; the magnetic lines of which circulate through the iron ring or core and cut the secondary coil at right angles and generate a current, as shown by the galvanometer, when the battery circuit is closed or opened.

A Step-Up Transformer.—If the primary coil is made of *100* loops and the secondary of *5000*, the electro-motive force in the secondary will be fifty times as great as that in the primary.

This illustration of a step-up transformer, Fig. *24*, may be reversed to show that of a step-down transformer by making *5000* loops in the primary coil and *100* in the secondary, in which case, the voltage of the secondary is $\frac{5000}{100} = 50$.

This ring demonstrates the law that the ratio of the voltage in the secondary to the voltage in the primary is as the number of loops in the secondary is to the number of loops in the primary.

On the contrary, the ratio of the current in the secondary is to that in the primary inversely as the ratio of the voltage in the secondary is to that in the primary: for example,—With *500* volts in the secondary and *5* in the primary, the amperage will be *5* in the secondary and *500* in the primary.

The number of volts × the number of amperes in the primary—less some loss in the transformation —is always equal to the number of volts × the number of amperes in the secondary.

The amount of voltage and amperage in the secondary is directly related to the amount of current in the primary, to the density of the magnetic field and to the frequency of the linking and unlinking of the secondary loops by the magnetic lines. The magnetic flux is equal to the magneto-motive force divided by the reluctance.

The magneto-motive force, in the secondary, upon which the voltage depends, is directly related to the current in the primary, to the frequency of making and breaking the primary circuit, or to the frequency of the revolutions of the armature of a dynamo.

In an average induction coil, giving a ten inch spark, the primary wire consists of *100* yards of copper wire, the coil diameter *264* m. m. its resistance being *1/3* of an ohm. The secondary is ten miles long and has a resistance of *6500* ohms.

THE DIRECT CURRENT TRANSFORMER.

The apparatus used to transform continuous currents is a motor-dynamo. Two armatures are wound on one shaft, one coil receives a small current at a high pressure, driving the other which acts as a dynamo, giving a larger current at a low pressure. "The windings are proportioned to the voltages and their sectional areas to the amperes."

An Alternating Current Transformer.—Instead of producing an alternating current in an induction coil by means of making and breaking a direct current in the primary, an alternate current street dynamo may give to the primary coil of the machine an alternating current to excite the secondary coil to give out other alternating currents.

INDUCTION OF CURRENTS BY MAGNETS.

If a coil of insulated copper wire forms a circuit, and a bar magnet be rapidly inserted into or withdrawn from the hollow of the coil, transient currents are produced and the current is much the stronger at the withdrawal. If the magnet is placed in the coil and left motionless, no current is produced. Whether a primary current or a magnet is used to produce induction in a secondary coil, the induction is always caused by the invisible, magnetic lines of force of the current or magnet, which cut the loops of the secondary coil. It requires one hundred million of these lines to produce one volt, if they cut *one loop* of the coil in one second; or one million lines, if they cut *100 loops* in one second.

In practice, when an induced current is obtained by the motion of an electro-magnet or electro-magnetic coil, the process is called electro-magnetic induction.

When permanent magnets are used to produce the magnetic lines or "field flux" the generator is called a *magneto-electric machine* or simply *magneto.* The action of the "hand magneto" depends upon an arrangement, by which, two bobbins of wire are revolved by hand between the poles of a permanent magnet.

THE DIRECTION OF THE INDUCED CURRENT.

A magnet is given its distinct polarity when excited by a current in a certain direction. If this magnet is withdrawn from a coil, it will excite a direct current in the coil,—that is a current in the same direction as gave the magnet its polarity. The current caused by *inserting* the magnet is an inverse current. If the coil is moved towards and from the magnet, the resulting current will have the same direction as when the magnet is moved towards and from the coil. The same effect is produced upon the secondary conductor or coil as when a magnet approaches a coil, that is,—the direction of the current in the secondary is opposite to that in the primary. Upon breaking the circuit, the direction of the current in the secondary is the same as that in the primary. The secondary current, produced by the *opening* of the primary circuit, is so much stronger than the secondary which is produced by the *closing* of the primary circuit, that it gives a severe shock, as compared with the feeble shock of the closing.

In the application of the secondary current to the patient, each electrode is, alternately, anode and cathode, in rapid succession. Still, the opening current is so predominant, that it is justifiable to consider that the electrode connected with it is the anode and the other the cathode. The comparative weakness of the secondary, when the primary is closed, is due to the self induction of, or extra current in, the primary, hindering the growth of its current, and thus causing the slow rise of its magnetic field or lines of force which cut the secondary coil. On the contrary in breaking or opening the primary circuit, the magnetic core of the secondary is suddenly demagnetized; and, in the process, the magnetic lines, suddenly collapsing, increase the induction current of the coil. For example, if one thousand lines cut a coil in one-fifth of a second, they produce five times as much voltage as they would in cutting the coil in one second.

THE ALTERNATING CURRENT GENERATOR.

The construction of the alternating current generator is indicated in Figure 25. N. and S. are the terminals of a horseshoe permanent or of an electro-magnet; B. C. the wound armature. On the armature are two contact rings E. and D. on which two brushes, F. and G. press.

The direction of the field in the magnet is from N. through the armature to S. making B. the North pole and C. the South, repelling the armature and revolving B. C. in the direction of the arrows. While B. is making one-half a revolution from N. to S., the current is passing from B. through the contact brush F. and the patient X. at H.

In the next half revolution, the current is reversed by passing from N. to C. to E. to the contact brush G. and the patient at I. Thus, at each half turn, the contact rings and the electrodes become alternately + and —. In each complete revolution, the electro-motive force rises in one half to maximum and falls to zero; then reverses, grows to a maximum and falls to zero. Each revolution is called a period or cycle and the frequency of the alternations is twice the number of the cycles.

Figure 25 demonstrates that the revolving of an armature in a magnetic field produces a change in the direction of the electro-motive force and the current at every half turn.

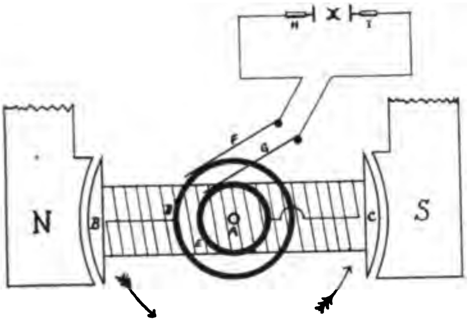


Fig. 25.

Continuous Current Generator.—When the supply current is an alternating one, the best means of securing a direct current is to drive with it a motor at one end of a shaft, at the other end of which is a direct current generator.

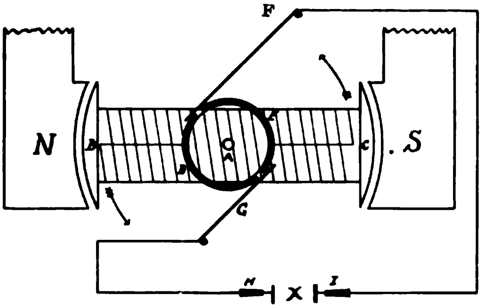


Fig. 26.

The action of this, see Figure *26*, is the same as that of the alternating current generator, except that in the former the current is made to pass in one direction only by means of a divided ring D. E. called a commutator. By this means, either one half D. of the ring or the other half C. of the ring is constantly in series connection with the brush F. and I. the plus side, while G. is in constant contact with the sides of the ring in contact with F.; thus there is a unidirectional current from F. through the patient to G.

The Action of Magnetic Lines of Force Upon a Field Magnet.—The illustrations, see Figures *27*, *28*, *29*, are taken from C. H. W. Bigg's excellent work, entitled, "First Principles of Electricity and Magnetism."

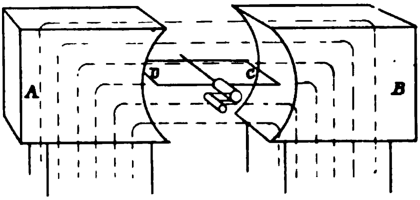


Fig. 27.

In the position shown, in Fig. *27*, none of the lines of magnetic flux pass through the armature coil, and, consequently, no current is induced therein. If the coil is set in motion, it successively embraces a

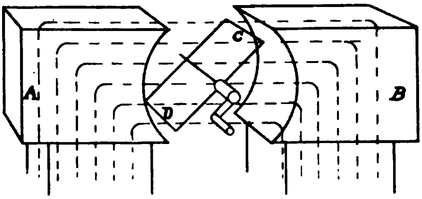


Fig. 28.

constantly increasing number of lines of force, and a current is induced which attains its maximum when the coil is in the position shown in Figure *29*, and all the flux passes through the coil.

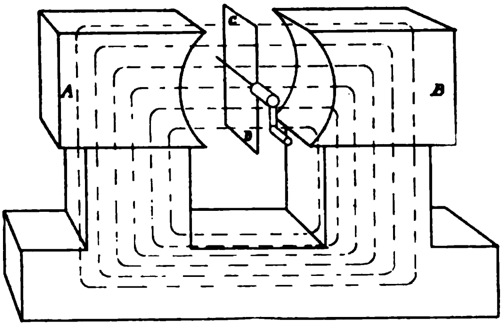


Fig. 29.

A moment's inspection of the figures will show that, at each half revolution of the coil, opposite faces are brought in front of A., and, consequently, the flux must enter the coil from one side during the first half of the revolution and from the opposite side during the remainder: the current resulting will, consequently, be of an alternating character.

THE SINUSOIDAL CURRENT.

In any current, in which the rate of flow is not constant, a more or less regular pulsation or wave results. In the faradic coil, this wave takes the shape of a rapid rise, followed by a slower drop to a minimum value. Such sudden changes produce a current that is harsh in its effects, and, if of appreciable magnitude, productive of considerable discomfort to the patient. In order to obtain an alternating current that is free from abrupt changes, a generator of the magneto type, as indicated in Figure *30*, is employed.

If the armature of such a generator is rotated at a uniform rate of speed, it will move through equal angular intervals of time, and the resulting electro-motive force will follow the simple sine curve, where E. M. F. = A. sine O.; where A. is a constant, depending upon the construction of the generator, and O. represents the angular position of the armature at any given instant of time. Such a curve is an example of simple *harmonic* motion,—so called because the vibrations of musical notes are of this type,—and is best defined as an oscillating motion, in which the amplitude or height of the vibrations is independent of the time.

If the constant A. is known, the voltage curve may be calculated by multiplying the sines of the angles that the armature makes with the plane of the lines of force at equal intervals of time; or, it may be shown graphically, as in Figure *30*.

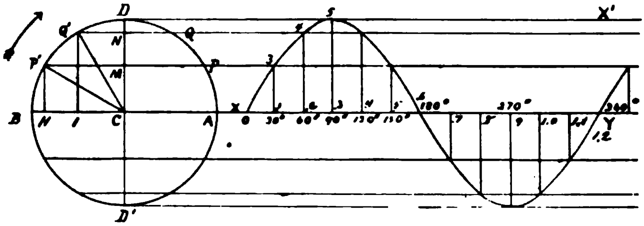


Fig. 30.

In the above diagram, if B. represents a particular place on the armature of a generator, and the armature is revolved at a uniform speed, B. will be successively carried to P', Q', D. etc., in equal intervals of time. If, now, we draw a horizontal line B. Y. through the axis of rotation C., and on this line, as an ordinate, indicate the time intervals; and, above and below this line, other lines which represent the position of B., when in the different angular positions due to this time, the slope of the curve will be shown by the points in which lines perpendicular to the time cut the lines showing the angles. These perpendicular lines are a graphic representation of the sines of the corresponding angles; P^1 H, for instance, being the sine of the angle P^1. C. B. and its projection on the horizontal line B. Y. locates the point *3*.

The curve shows the rate of increase and diminution of the voltage that would occur if B. were to be turned through a complete revolution in *1.2* seconds; the part above the line B. Y. indicating a positive and that below the line a negative value in the resulting current. Such a voltage curve has, probably, all the therapeutic values of the faradic current in producing muscular contractions and nerve stimulation; but, being free from abrupt changes, allows the contractions to occur in a rhythmic manner, instead of by the irregular jerks, the sudden changes of voltage that the Faradic current induces.

Although the curve, shown in Figure *30*, is drawn to show a periodicity of *1.2* second, it may be readily seen, from an inspection of the drawing, that the height of the curve is independent of the time, and that a wave of the same height, but of a faster or slower slope, can be obtained by the simple expedient of varying the speed of the armature. By such change, we can obtain the rapid reversals of current that are sedative in character, or the slower rise and fall that permit of rhythmic contraction of muscles.

LIGHT.

Every luminous body emits divergent rectilinear rays along the lines of propagation, from all its points and in all directions.

The waves or vibrations of light and heat are at right angles to the lines of propagation.

A familiar illustration of the combined vibrations and propagation of light is given in the shaking of a rope at one end. The to and fro movements of the particles of the rope are at right angles to the length of the rope, but the onward motion of the waves is in the direction of the length of the rope.

The vibratory motion, when transmitted to the retina, is interpreted by the visual centre as light or form.

An agent which travels lightly, as does light, at a speed of *190,000* miles in a second, (Fiseau), should command more than the usual respect for its force and penetration.

Similar to the law of the *x*-ray, and of heat propagation, the intensity of illumination falling perpendicularly on a given surface is inversely as the square of the distance from the source.

Refrangibility of Light.—A prism placed in the path of a beam of light, breaks it up into the single colors. The colors of the spectrum, from red to violet, are increasingly refrangible, or bent toward the *base* of the prism. This is due to the various lengths of the undulations which produce the colors. The red light is due to comparatively long, infrequent undulations, hence it penetrates the prism, as it does the body, with less deflection, while the violet light, which, with its short rapid vibrations, is most deflected toward the base of the prism, penetrates the body less deeply.

HEAT.

A ray of *heat* consists of ethereal vibrations which pass through space and from one body to another with the velocity of light.

Heat not only expresses a particular sensation but a state of matter which may be transmitted to bodies, produce electric currents,—as, in the thermopile,—and decompose compound bodies.

According to the *theory of undulation,* the heat of a body is caused by an extremely rapid vibration of its molecules. To increase the temperature of a body is to increase the rapidity of its molecular vibrations. To lower the temperature, is to lower the rapidity of the vibrations.

Hence, heat is a *condition of matter,* which can be transmitted from one body to another.

A hot body sets the universal ether in rapid vibration which may be communicated to other bodies to heat them. This theory shows an intimate connection between heat and light. By the friction of bodies, an indefinite amount of heat can be produced. Even a solid body may be made to vibrate against the air with sufficient rapidity to cause it to ignite.

The electrical vibrations of a high frequency current, transmitted to the body, rapidly cause a sensation of heat—which is, probably, due to molecular vibration of the body, to the resistance of the body to the current, and, to the physiological exchanges.

TRANSMISSION OF HEAT.

The heat which we feel, when toasting ourselves before a fire, is called *radiating heat:* that is,—it is radiated directly to us from its source, without heating the intervening atmosphere. In proof of this,—if a solid screen is placed in front of the fire to intercept the radiation, no warmth is felt.

Heat may also be transmitted by conduction, as when one end of a metal bar is heated, an increase of temperature gradually travels to the opposite end. The capacity of metals to conduct heat is almost identical with their capacity to conduct electricity.

Radiant Heat.—Heated bodies can send out rays which penetrate the air without heating it, as rays of light pass through transparent bodies without heating them. These rays of light are called *thermal* or *calorific rays.* Not only luminous bodies, but bodies of all temperatures radiate heat. The visible part of the heat spectrum is called *luminous,* and the invisible part, *obscure.*

Laws of Radiation of Heat.—These are the same as for light.

1. In a homegeneous medium, radiation takes place in all directions, in a straight line from a body.

2. In passing obliquely from a medium of one density to that of a different density, heat rays suffer the same *refraction* as do light rays.

3. Radiant heat is propagated in a vacuum as well as in air.

4. The intensity of radiant heat is inversely as the square of the distance from the source.

5. The intensity is less, the greater the obliquity of the rays.

The importance of these two last laws, in regulating the distance of the lamp from the patient, and in placing the lamp at right angles to him, is evident.

Distribution of Heat.—When heat rays fall upon a body, one portion is reflected regularly,—the angle of reflection being equal to the angle of incidence,—another portion is reflected irregularly, and is called scattered or diffused heat; another is absorbed by the body; and, still another passes through it.

Radiating Power of a Body.—This is its capability of emitting greater or less quantities of heat.

Dulong and Petot determined that the radiating power of a body is equal to the absorbing power of the same body.

The absorbing power is greatest when the rays are at right angles to the surface,—as the summer heat of the sun demonstrates.

Thermal Analysis of Sunlight.—If a thermopile is placed in the light spectrum, opposite each of the colors, in turn, from the violet to the red, it will be little affected by the violet, but will show a gradual rise of temperature, which is greatest at the red and increases up to a certain distance in the infra-red.

The thermal rays are not confined to the red rays.

On the other hand, the green, red, and infra-red rays will all act on a photographic plate.

The only distinction between the light, heat and chemical rays is that of *wave length.*

Tyndall determined the heat spectrums of electric light was the same as the solar spectrum, but the intensity of the heat in the infra-red of the solar spectrum is less than in the electric; probably because the aqueous vapor has absorbed the sun's heat.

Diathermancy. — Diathermancy, (dia—through thermos—heat) expresses the power that bodies have of transmitting heat.

Melloni found that of every *100* heat rays to which rock salt was exposed it transmitted *92*; while, alum only transmitted *12*—or cut off *88*.

Influence of the Source of Heat On Transmission.—Plate glass transmits only *24* per cent. of the heat from an incandescent platinum wire. The greater part of the heat radiation from the wire is due to the infra-red,—and glass is opaque to this kind of radiation. It follows that a plate glass shield, in front of a therapeutic lamp, would transmit—of the total energy—all the light energy; that is *10* per cent. of the whole and *24* per cent. of the heat energy.

Alum transmits only *2* per cent. of the heat energy of an incandescent platinum wire, while rock salt transmits *92* per cent. of the heat energy from any source and is said to be the only substance which does so.

Melloni concluded that as the temperature of the source rises, the percentage of the heat transmitted through a body increases; that is, the percentage of the rays absorbed diminishes. This, of course, does not mean that a body exposed to the heat of a *100* candle power lamp actually absorbs more heat than when exposed to a *500* c. p. lamp,—but that a larger proportion of the heat of the *100* c. p. lamp is absorbed than of the *500* c. p. lamp.

The above is very analogous to the amount of absorption and transmission of the intense and low energies of x-rays,—the higher energies being the more freely transmitted and the low absorbed.

Influence of the Thickness of Screens.—Almost as much absorption takes place in a glass screen *0.5* m. m. thick as in *8* m. m.—as nearly all the absorption takes place in the first layers, near the source of heat.

The heat and light from the same source can be separated. Rock salt, coated with iodine, completely stops all the light and transmits the infra-red or heat rays. On the other hand, a solution of alum or a layer of water is permeable to light, but stops all the heat. Hence, a vessel of water can be used to intercept the heat of an electric lamp.

Sources of Heat.—The following are the chief sources of heat:—The sun, chemical combinations (as in combustion), and decomposition, inhibition, absorption, capillary actions,—in short, all vibratory phenomena in which elements, molecules or masses play rough and tumble with each other.

Animal Heat.—When the human body is at rest, all its functions, by processes of oxidation, etc., are transformed into heat. When at work, the increased oxidation of the working parts is transferred to the other parts. In addition all the molecular and gross vibrations of the body, in all its functions, and activities produce heat.

Lord Kelvin has pointed out the fact that there exists a tendency to the conversion of all other forms of physical energy into heat and to the uniform diffusion of heat throughout all matter.

A store of chemical power consisting of uncombined elements combine and produce energy in the form known as electric currents, a part of which can be employed to produce heat. On the other hand, a visible motion is ultimately converted into heat by the agency of friction. There is then, consequently, a tendency towards a state in which all physical energy will be in a state of heat and that heat so diffused that all matter will be at the same temperature; so that there will be an end of all physical phenomena.

THE X-RAY.

X-rays are composed of infinitely short transverse waves, propelled in straight diverging lines; their mass being inversely as the square of the distance. They are produced in a Crooke's tube, exhausted to a vacuum of *.000,001* of the pressure of the atmosphere, which is traversed by a very high tension electric current of a Rhumkorff coil or a static machine. The tube has, at one end, a cupped *cathode,* and, at the opposite end, two connected anodes. The one which is in line with the cathode is the *anode proper.* The other terminates in a flat disc or tagret and is the *anti-cathode.* In connecting up the tube, the anode of the exciting machine should be connected with the anode of the tube.

THEORY OF THE PRODUCTION OF X-RAYS.

It was known that only a small current could be sent through a gas by a moderate electric intensity, but, with a high intensity, a considerable current would pass. A vacuum can be produced, through which no current can be made to pass. A stream of particles, (Guilleminot thinks probably *hydrogen*), flows from all parts of the anode end of the tube toward the cathode, receives a negative charge, is then repelled with tremendous velocity and focussed upon the anti-cathode target, where the cathode rays are "stopped and absorbed" and Roentgen rays are emitted and ejected through the wall of the tube in front of the target.

Roentgen found x-rays affect a photographic plate in the same manner as light.

J. J. Thompson showed that they produce conductivity in any gas through which they pass. The rays are very similar to light rays, but they are not refracted when they pass from one medium to another of different density. They also resemble cathode rays, but they differ from them in carrying no electric charge.

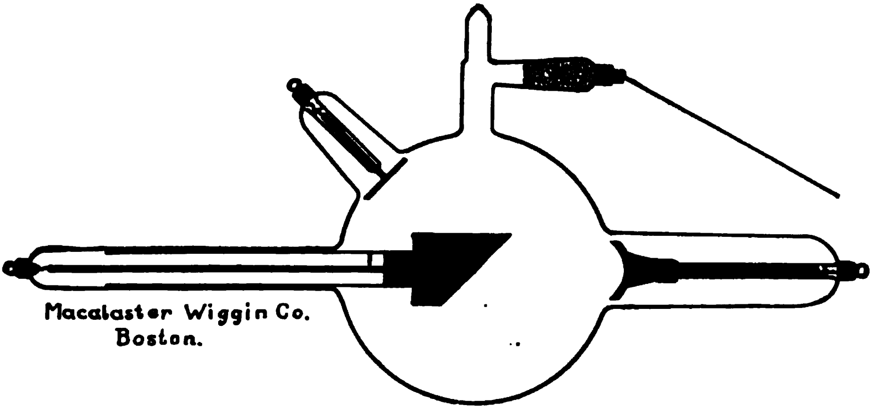


Fig. 31.—Tungsten Target Tube.

CHAPTER II.

ELECTRO-THERAPEUTIC APPARATUS.

In the present chapter, the intention is to call attention to the prevailing types of electro-therapeutic apparatus in general use rather than to advertise the product of any particular manufacturer, for, while the mechanical details may vary widely according to the individual ideas of different makers, the purposes for which such apparatus is intended are alike with all, and the high standard of workmanship generally prevailing is such that comparisons are unnecessary. Apparatus suitable for the uses of the physician is to be had of any of the regular instrument supply houses, and the pages of the prominent journals contain many advertisements of other makers who are producing special apparatus of recognized worth.

If, in the selection of illustrative cuts, undue prominence seems to have been given the apparatus of certain manufacturers, it is due to the fact that the author has described that with which he is personally familiar as being typical, not that he considers it as necessarily superior to that made by other representative makers.

THE GALVANO-FARADIC WALL PLATE.

In the usual type of wall plate, (see Figures *32* and *33*) the direct current of the plate is supplied by the street service. The strength of current required is obtained by placing in series with the patient, a rheostat. The galvanometer of the wall plate measures the current in the patient's circuit. A switch or pole changer is used to change the direction of the current as required.

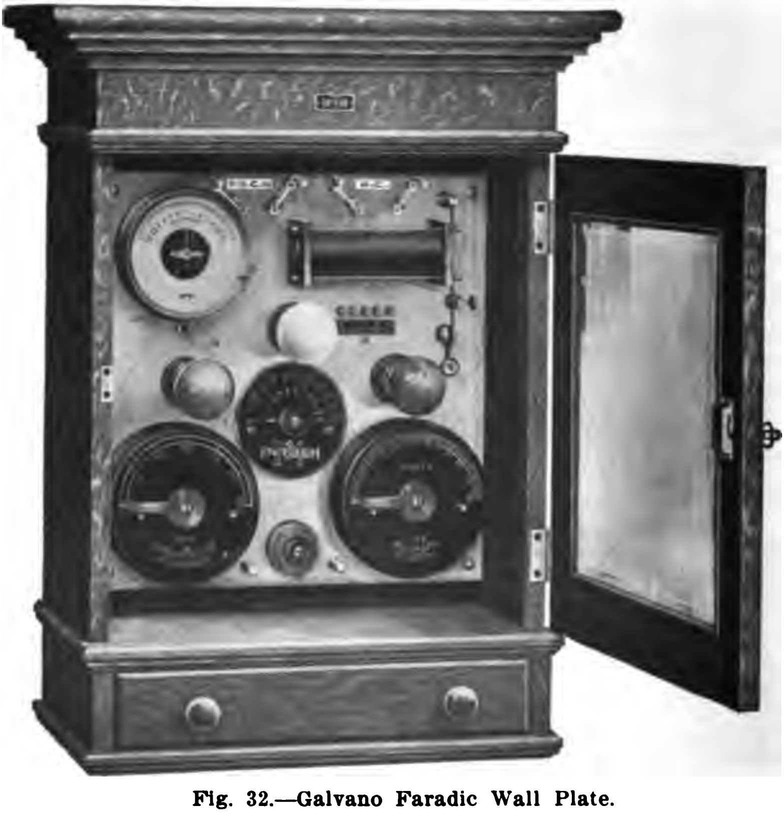


Fig. 32.—Galvano Faradic Wall Plate.

The Faradic Coil of the Wall Plate.—This is a small coil, consisting of a primary coil of stout insulated copper wire of a few turns, within which is a soft iron core of parallel wires; and, around the coil and insulated from it, is a secondary coil of finer insulated copper wire of many turns.

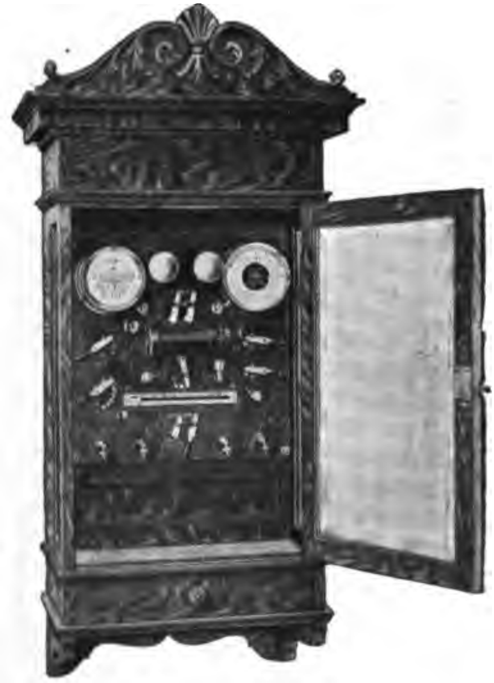


Fig. 33.—Wall Plate.

The induction in the secondary coil is produced by making and breaking the primary circuit with an automatic hammer. The hammer, and the regulating screw, against which it presses, have platinum surfaces at the points of contact, to minimize the corrosion of the sparking discharge. The spring hammer is in the primary curcuit when it is at rest against the screw. When the current is turned on, it magnetizes the core which attracts the

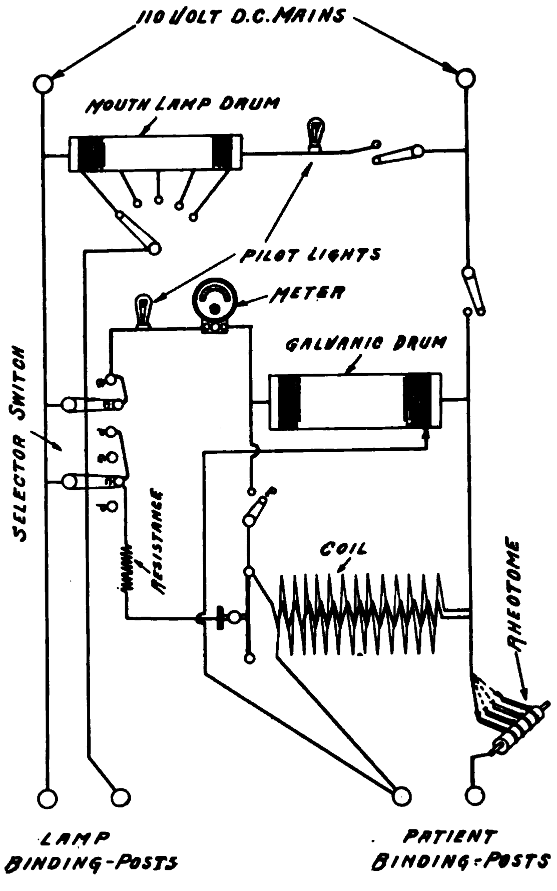


Fig. 34.—Diagram of Wall Plate Connections.

hammer to it, removes the hammer from the screw and breaks the circuit,—thus demagnetizing the core and releasing the hammer, which then flies back to the screw, when the process is renewed.

Rheotome.—The office wall plate is usually supplied with an automatic circuit breaker or rheotome, the purpose of which is to convert the constant direct current into a pulsating direct current, which, in many of its effects, is similar to that produced by the faradic coil, but is unidirectional instead of alternating, as in the latter coil.

THE HIGH-FREQUENCY INDUCTION, OR RHUMKORFF COIL.

Except in size, this does not differ in construction from the small coil of the wall plate.

The current of a Rhumkorff coil is of an alternating character, but with the negative phase much stronger than the positive. It is then possible to obtain an intermittent pulsating current of unidirection by means of a suitable commutator, or, as is usual, to introduce a spark gap in one of the lead wires. The purpose of this gap is to suppress the weaker wave by acting as a resistance to its passage.

The polarity of the prime conductors of the coil is indicated as follows:—The disc acts as a condenser, and, if it is the *positive pole,* the discharge takes place, as from all condensers of a similar shape, at the edge.

When the positive charge is from the opposite small electrode, it strikes the disc at an indefinite place between its centre and circumference.

Voltage of the Coil.—Under similar conditions of size of the prime conductors, etc., a coil demonstrates the voltage when it gives an inch spark as does the static machine.

Condenser.—In order to minimize the effect *"at make"* of reverse currents of self-induction, which would act as an impedence in the circuit and prevent the current attaining a proper maximum, a condenser, usually consisting of insulated sheets of tin foil, is inserted as a shunt across the terminals of the interrupter.

THE OUDIN D'ARSONVAL RESONATOR.

This is usually furnished as an attachment to the coil or static machine and consists of a coil of coarse wire of few turns wound around the base of a cylinder of wood and terminating in a coil of fine wire of a greater number of turns. The coarse wire coil, the relative length of which is adjustable, acts as an impedence coil to the discharge from a pair of Leyden jars, the rate of the discharge being controlled by a spark gap.

As the jars are charged with a sufficient force to overcome the resistance of the air gap of the rods, a spark passes between them and empties the jars. The induced charges on the outer surface of the glass of the jars are thus released and rush through the conductors to the resonator.

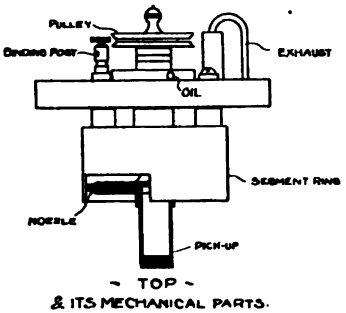
The spark discharges consist of to and fro oscillations which may vary from ten thousand to tens of billions per second. The charge from the Leyden jars produces self induction in the resonator and also a resonance which should be synchronous with the vibrations of the spark gap of the jars. These vibrations once set up in the resonator tend to increase in frequency and thus add to the voltage and capacity of the coil. The vibrations of the spark gap and the resonator must be in harmony in order to get the greatest effect from the coil. The current delivered to the patient is much greater when the vibrations of the resonator are harmonious with those of the spark gap of the jars than when they are not.

This can be demonstrated by the relative amount of current thrown into the circuit, proving that the effect of the current on the patient is less with inharmonious vibrations than when the current is *diminished* to produce harmonious vibrations.

In lieu of the resonator in circuit with the high-frequency coil, Tesla employs an induction coil of a few turns of coarse wire within a coil of fine wire of very many turns. This acts as a step-up transformer to very greatly increase the voltage of utility.

The Interrupter.—Three principal methods of opening and closing the circuit in the primary of the high-frequency coils are in use: the hammer, the mercury turbine and the electrolytic. The first has already been considered.

The Mercury Turbine.—This consists of a turbine wheel revolving within a suitable case. The revolutions of the turbine operate to project a stream of mercury which makes intermittent contact with the walls of the case. The connections are such that the mercury stream is in series with the main circuit, the current in which is broken each time the mercury jet is interrupted. See figures.



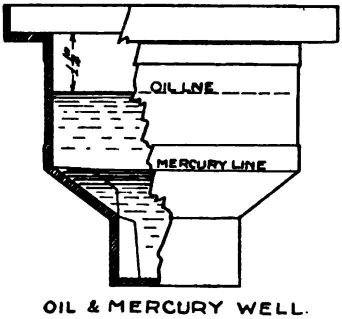


Fig. 35. Mercury Turbine Interrupters. Fig. 36.

Wehnelt's Electrolytic Interrupter.—This interrupter consists of an anode of platinum wire, insulated, with the exception of the extreme end and a lead plate cathode; the two being immersed in sixteen per cent. of sulphuric acid in water.

When a current passes from a source of twenty to one hundred volts, the platinum glows intermittently. The current sets free hydrogen, which gathers on the cathode in the cell and prevents a further passage of the current. As the bubbles of hydrogen escape into the surrounding electrolite, the current is again established. The circuit is thus made and broken very rapidly. See Figure 37.

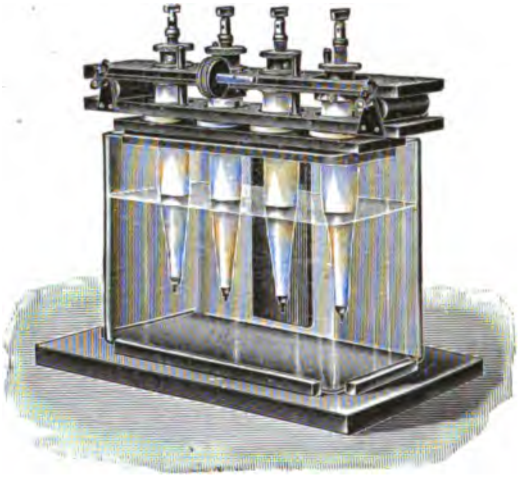


Fig. 37.—Wehnelt Electrolytic Interrupter With Heavy Platinum Anodes Connected in Parallel and Used for Instantaneous and Tele-radiography.

A transformer is usually an induction coil, by which a primary current of high initial electro-motive force is made to produce a secondary current of low initial electro-motive force. This is a *step-down* transformer. Fig. *38*.

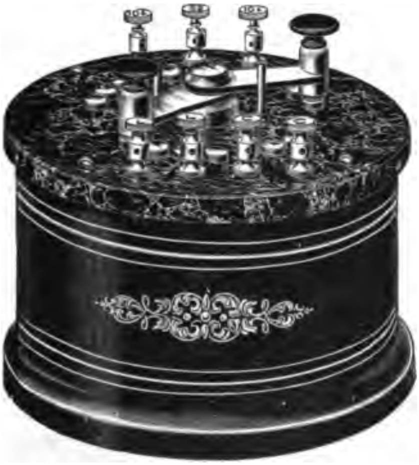


Fig. 38.

A *step-up* transformer transforms a current of low electro-motive force into a current of high electro-motive force.

The term transformer is also applied to a device by means of which alternating currents are changed into continuous ones and vice versa.

SINUSOIDAL APPARATUS.

In the modern type of apparatus, designed for the production of currents having a sinusoidal wave, there is little to remind one of the "shocking machine" of our fathers,—a coil of wire revolved between the poles of a permanent magnet.

About twenty years ago the designers of electrical machinery called attention to the shape of the wave as a factor in the design of apparatus and the effects of the current produced; and it is to Edison, I believe, that the introduction of the sine wave into the domain of therapeutics is due. The first apparatus was capable of affording waves of a fixed periodicity only, later types enabled the rate to be varied and afforded currents suitable for a wide range of uses; and at present we have offered us

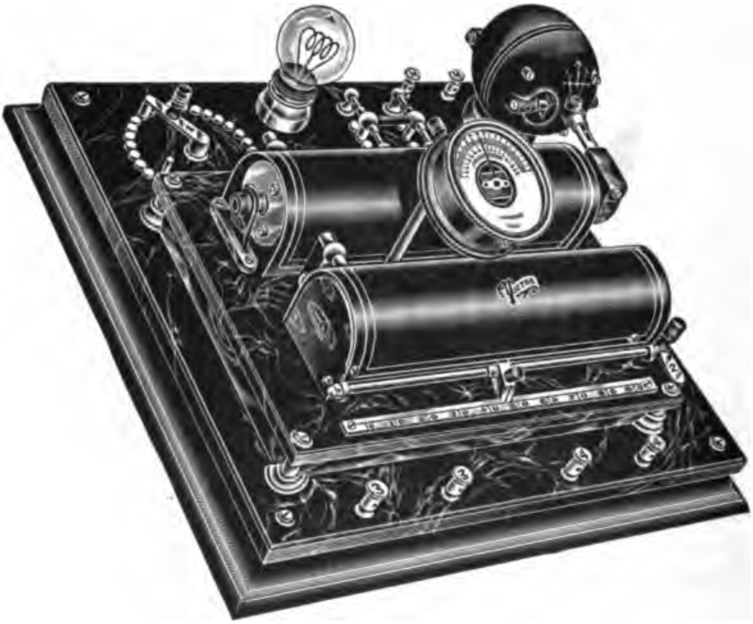


Fig. 39.—Multiplex Generator.

machines in which the wave length can not only be varied but in which two or more waves of different length and amplitude can be superimposed. See Figure *39*.

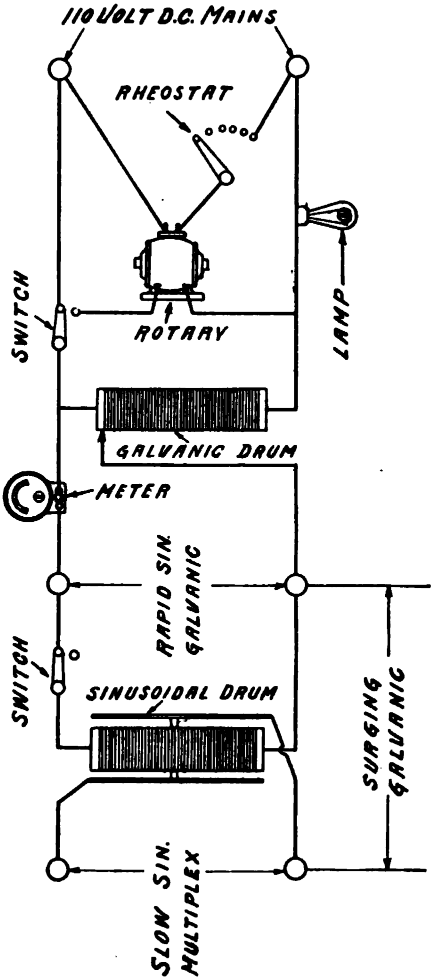


Fig. 40.—Diagram, Showing Construction of Multiplex Generator.

As to the utility of superimposed currents, there may be a difference of opinion, but as to the

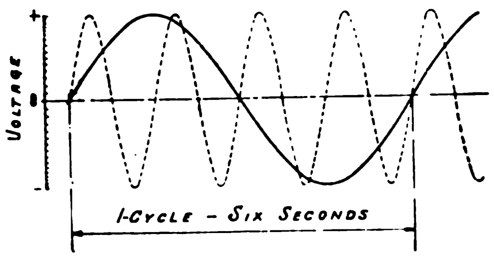


Fig. 41.

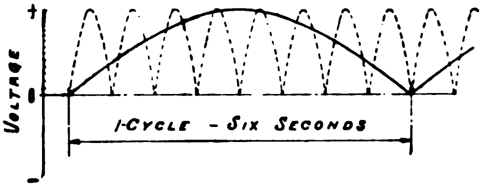


Fig. 42.

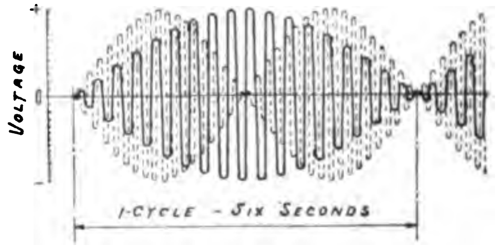


Fig. 43.

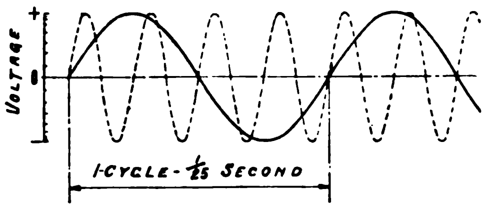


Fig. 44.
Compound Sine Curves of Multiplex Generator.

utility of the different wave lengths, there can be no doubt, as, with a proper machine, it is possible to obtain currents of such rapid reversals that the muscle tissue cannot respond and the nervous system alone receives the waves so slowly that they excite rhythmic contractions of the muscles and influence metabolic processes.

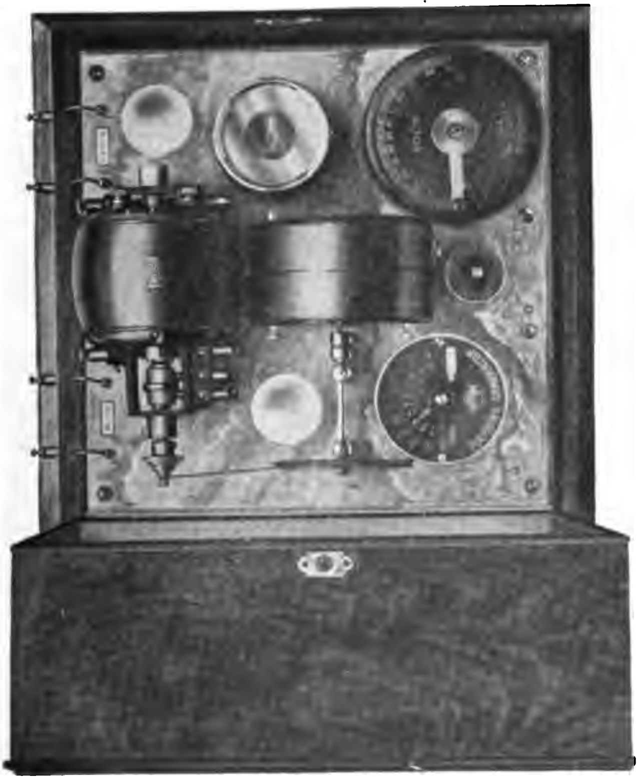


Fig. 45.—No. 1 Polysine Generator.

As the alternating current is rapidly replacing the direct for commercial purposes, it is possible to derive the sinusoidal current direct from the mains, but, owing to the fact that such current is of a fixed periodicity, its range of usefulness is practically limited to its sedative effect; the usual rate of sixty cycles per second being too rapid for muscular effects. When, however, the rate of the particular current at the operator's disposal is satisfactory for his purpose, the only apparatus needed for its control is a rheostat. This should, preferably, be of the shunt type and inserted in the circuit in series with a lamp of suitable capacity. The lamp is intended to act as a safety device to prevent an excessively large current entering the rheostat.

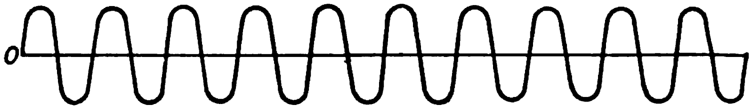


Fig. 46.

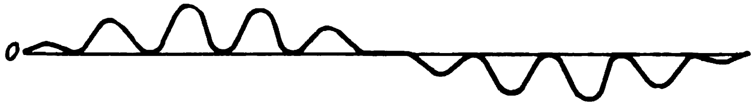


Fig. 47.

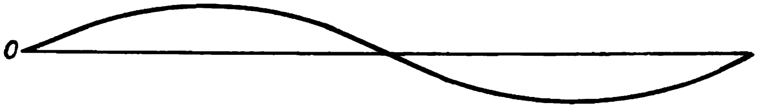


Fig. 48.

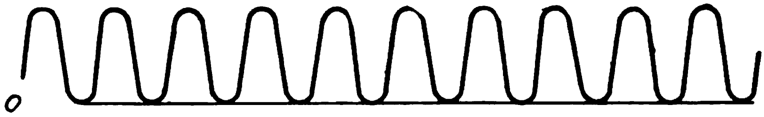


Fig. 49.

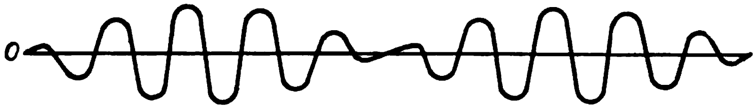


Fig. 50.

Characteristic Curves of Sine Waves. Polysine Generator.

The patient is connected in shunt with the rheostat and while the voltage of the curve is under control, the length of the wave is necessarily that of the supply current.

TRANSILLUMINATION.

One of the most valuable of the more recent aids to diagnosis is the transilluminator, which, as the name implies, is a device for illuminating the cavities of the body by means of a beam of light sent through the surrounding tissues.

At first of crude design and objectionable on account of the heat generated by the carbon lamps, formerly employed, it has now, since the advent of the Tungsten, or cold lamps, become an indispensable adjunct in the diagnosis of sinus diseases and of certain intra-ocular disorders.

Essentially, the transilluminator consists of a miniature electric lamp of high candle power and provided with a protective covering of opaque material, except for a small opening at the end.

If such an instrument be applied, for instance, to the healthy mastoid, the surrounding tissues will be lighted by a soft diffused light, but if the antral cells are filled with purulent matter, the area will remain dark.

By removing the opaque hood and substituting a glass covering, the transilluminator may be placed in the patient's mouth; if the lips are then closed tightly around it, the maxillary sinuses will become lighted up and can be readily outlined. If the lamp is sufficiently powerful, the eyes will be lighted and the diagnosis of intra-ocular tumors and retinal detachments can be outlined.

The uses of this particular instrument are so patent that many investigators have contributed to its development.

Among the best known forms may be mentioned those of Enihorn and Kuttner for the illumination of stomach and intestines; of Freer, for eye and accessory sinuses; of Würdemann and Gibson for the eye; and the general purpose one of Sachs. In the three latter forms, the property possessed by a glass rod of conveying a beam of light is made use of to confine the light to the exact region desired, and its use further permits the tip of the instrument to be brought into actual contact with the cornea in the case of eye examination.

In order to obtain the best results from instruments of this class, it is essential that the room shall be in total darkness, or that a screen, similar to a photographer's focussing cloth, shall be used.

Certain of these illuminators, notably Freer's and Sachs', may be used without the hood as an ordinary head lamp to illuminate the operative field.

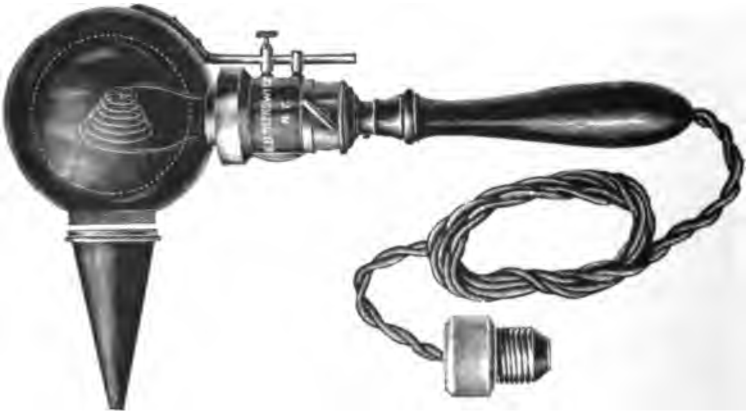


Fig. 51.—Sachs' Transilluminator.

RHEOSTATS.

A rheostat is an apparatus for controlling the strength of an electric current by changing the amount of resistance of the circuit. It is an indispensable part of the electrical equipment.

While many forms are on the market, the prevailing types for medical purposes are:

Water.—In this form, now but little used, a vessel of water forms a resistance which admits of variations by raising or lowering an adjustable conductor and thus varying the length of the column of water.

Compression.—This consists of an elastic, rubber, container, filled with granulated carbon. The initial resistance is high, but, by compressing the carbon grains by means of a screw, they are brought into more intimate contact and more current is enabled to pass.

Wire.—In this form, a wire of appropriate length forms the resistance and a movable contact allows any fractional portion to be introduced into the circuit.

Carbon.—A common type of this rheostat consists of a slate base, provided with a lever, capable of revolving about a fixed axis and making contact with a carbon coated surface. In the more simple types, this coating is applied by rubbing the surface with a soft lead pencil; in others, a mixture of clay and graphite is pressed into a groove cut in the slate and is caused to adhere by baking.

Volt Selecter.—This name is a misnomer, but it seems destined to remain for some time. What is really meant is a current controller, and it affords a means of regulating the strength of the current in the patient's circuit by means of shunting off, from a main supply, a current of any desired strength.

In this form, which is perhaps the most desirable when the commercial circuit is employed, a German silver or similar resistance wire of suitable length is inserted in series with the main current. By means of movable contacts, a branch circuit is formed, through which the drop in voltage and consequent current can be varied as desired.

Before the advent of commercial currents, the ordinary series rheostats were sufficient for therapeutic purposes, as the batteries were not sufficiently strong to admit of a dangerously large current. The high voltage of the commercial current, however, would necessitate so great an amount of resistance material as to render the usual types of rheostat of unwieldy size, so that, in order to render this current available, the shunt controller is more convenient.

As the purpose of a rheostat is to control the current, it is absolutely immaterial of what material it consists, so long as it will permit the necessary current to pass without becoming unduly hot, and will admit of the current being varied by regular amounts, but so evenly that the patient does not experience a shock as the lever passes from one contact point to another.

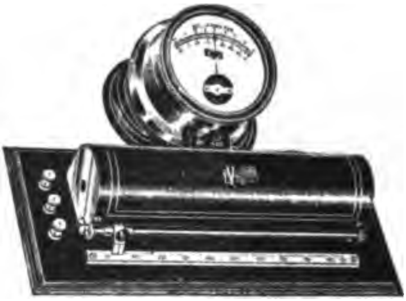


Fig. 52.

As supplied by the makers, the shunt controllers are marked with a scale of voltages, but, in actual use, such scales serve for comparative measurements only and afford absolutely no indication of the actual drop in voltage; the designers seeming to have overlooked the fact that a branch circuit operates to lower the resistance of the entire circuit.

Figure *52* shows a combined controller and meter; and, Figure *53* is a diagram showing the construction of the same.

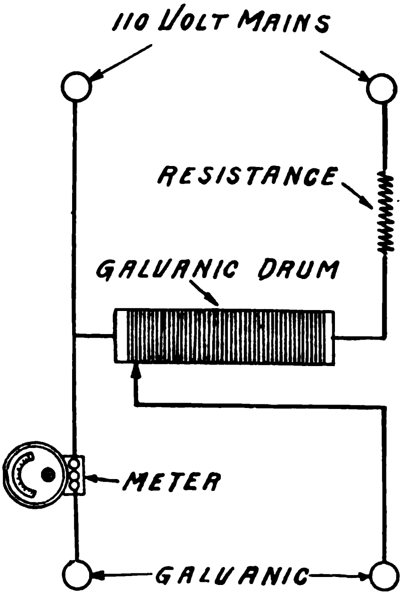


Fig. 53.

An ingenious little controller is shown in Figure *54* for attaching directly to a lamp socket and

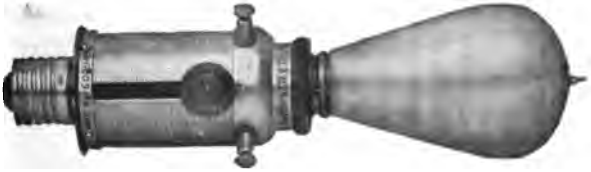


Fig. 54.

affords a ready means of regulating the small diagnostic lamp.

PROTECTIVE DEVICES.

Aside from the use of the rheostat to control the current, other means are provided to protect both patient and apparatus from the effects of a dangerously large current. Chief among these are:

Fuses.—A fuse is a short length of lead or composition wire inserted in the circuit and designed to melt and thus break the circuit if the current rises to dangerous proportions.

Automatic Cut-outs.—These are less in evidence than they should be. Essentially, they consist of a movable contact, held closed by means of an electro-magnet. In case the main current is broken from any cause, the contact is released and can not be again restored until the rheostat switch is brought back to zero. This prevents the shock that would occur to the patient if the circuit were broken and completed while he was under treatment.

A variety of this cut-out contains a second magnet that operates to open the circuit if the current should rise too high, but it is not yet adapted to medical uses.

Lamps.—An ordinary electric lamp, in series with the main circuit, forms at once a satisfactory and inexpensive means of reducing the commercial circuit to a suitable strength for the physician's needs. In effect, it is simply a rheostat of fixed capacity, but it has the further advantage of effectually opening the circuit if it should burn out and of acting as a pilot light to show that a current is passing through the apparatus.

RECTIFIERS.

In order to obtain a direct current from the commercial alternating circuit, some form of rectifying apparatus is needed. The following are the types employed in medical work:

Rotary.—In this form a motor, driven by the commercial current is used to drive a miniature dynamo, which produces the current required. In some forms of this apparatus, the two windings are superimposed on the same shaft. The combined form is usually known as a motor-generator.

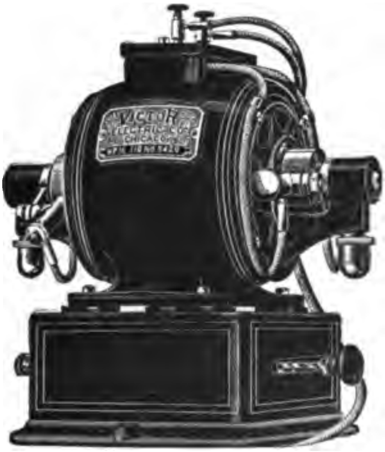


Fig. 55.—A Motor Generator.

Electrolytic.—The electrolytic rectifier owes its value to the curious property possessed by certain gases and metals of conducting a current better in one direction than in the other. As ordinarily made, this rectifier consists of an aluminum and an iron plate immersed in an ammonium phosphate solution. On connecting these electrodes to an alternating circuit, the current will flow only from the iron to the aluminum; the reverse wave being suppressed—and an intermittent current results.

In actual practice, however, the action is not instantaneous and there is often a small negative wave of sufficient magnitude to affect the proper working of an x-ray tube. In order not only to reduce this to a minimum, but also to utilize the suppressed wave, the expedient is adopted of connecting four such cells in series parallel. See Figures 56 and 57. The resulting wave is then of a pulsatory character.

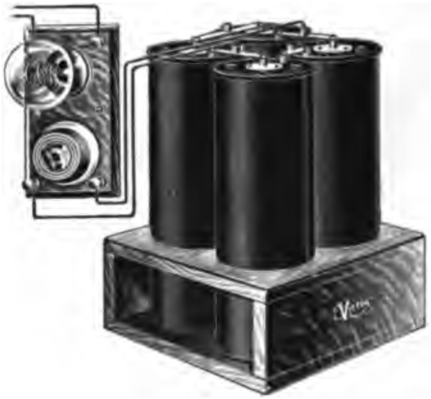


Fig. 56.—Four Cell Rectifier.

Meyer and others have further increased the efficiency of the apparatus by bridging a fifth cell or a condenser across the battery with the result of obtaining a current entirely free from reverse waves. See Figure 58.

Rectifiers of the above types are not alone useful for their medical application but, when of suitable size, will serve as well for charging storage batteries for cautery or automobile purposes.

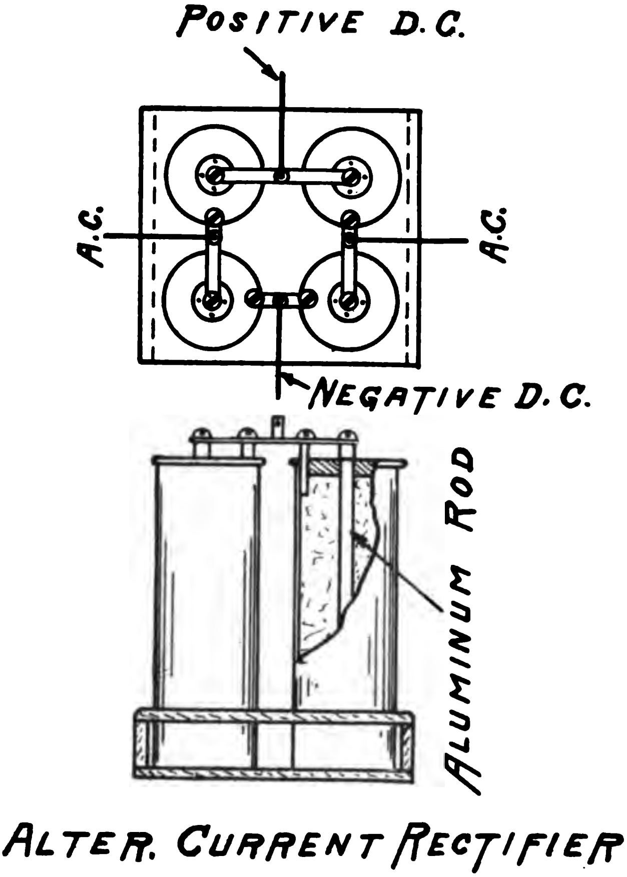


Fig. 57.—Alternating Current Rectifier.

MOTORS.

The electric motor is rapidly attaining an important position in the equipment of the office.

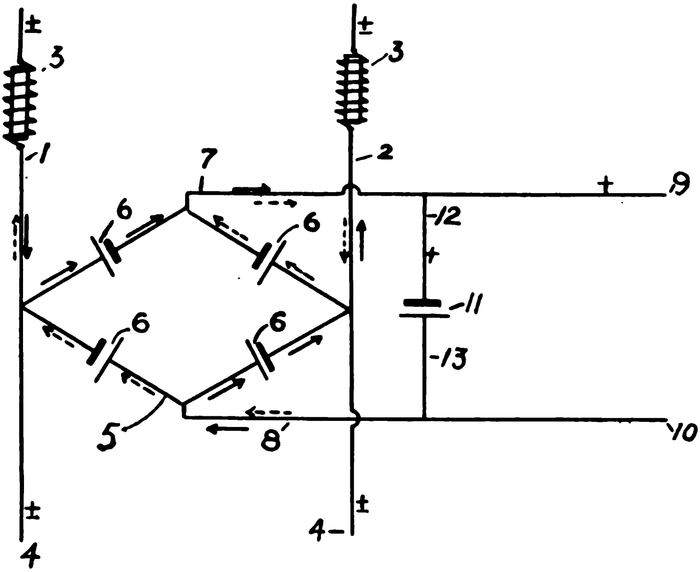


Fig. 58.—Five-Cell Rectifier.

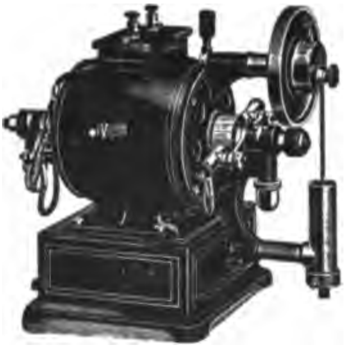


Fig. 59.—Motor Generator With Ear Pump.

In the above cut, Figure *59*, is shown an efficient type of motor, designed to operate on the direct current. On the right hand side is shown a small pump, designed for use in producing aural massage; while, on the left, is a provision for attaching a flexible shaft for driving burrs or vibrators. A supplementary winding on the armature of this machine furnishes an alternating current for charging storage batteries or heating cautery knives and lighting diagnostic lamps, and from it a very efficient sinusoidal current can be derived.

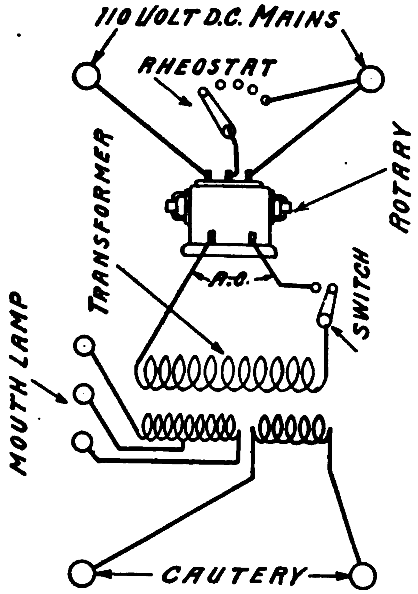


Fig. 60.—Starting Rheostat, Rotary Transformer, Cautery and Diagnostic Control.

This diagram shows the connections of the motor shown in Figure 59 above. At the top is a rheostat for controlling the speed of the motor and regulating the length or periodicity of the alternating current; while, below is shown the scheme of the transformer, by means of which the voltage is adapted to the needs of a diagnostic lamp or a cautery electrode.

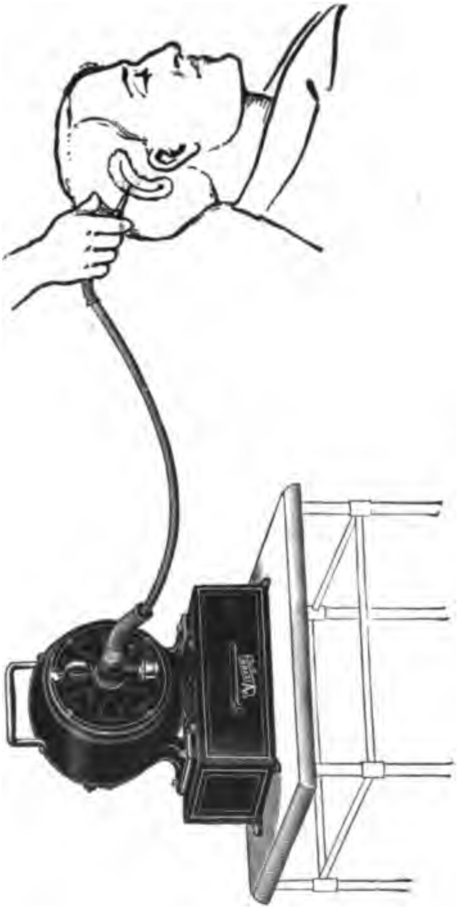


Fig. 61.

In this figure is shown the motor as used in bone surgery; a flexible shaft, similar to that used on a dental engine, being used to drive the necessary drills or cutting burrs.

LOCALIZATION OF FOREIGN BODIES IN THE EYE.

The presence of a foreign body within the eye or in the surrounding tissues is usually determined from the examination of a skiagram. Its exact localization, however, is a matter of considerable difficulty, as, owing to its anatomical position, it is impossible to skiagraph the eye from two positions, at right angles to one another; and several ingenious methods have been developed to overcome this trouble.

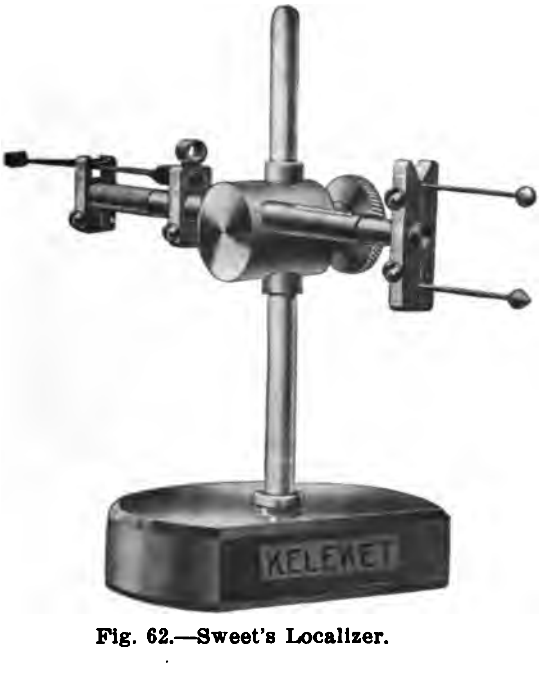


Fig. 62.—Sweet's Localizer.

Dr. Sweet makes use of a localizer, consisting of a metal ball and a cone, fifteen m.m. apart, and so placed before the eye that, by their shadows, cast on

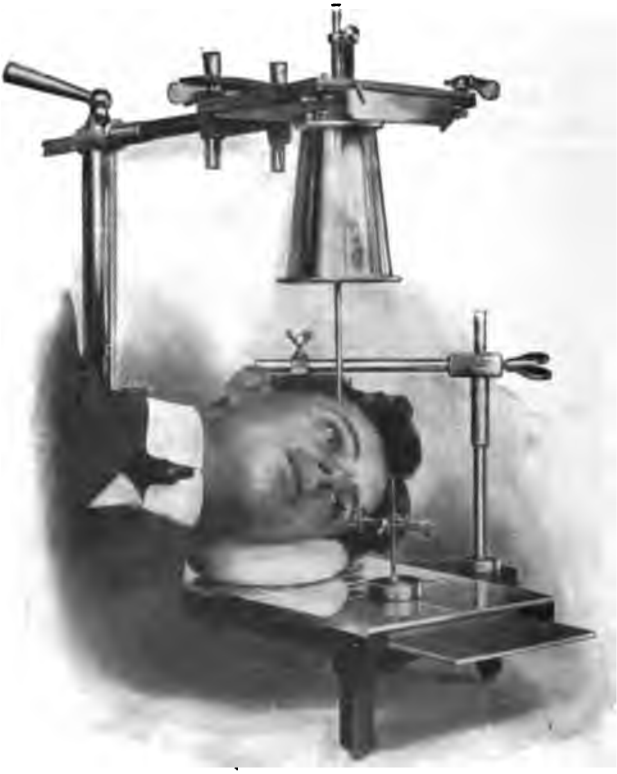


Fig. 63.—The First Exposure.

the plate, we are enabled to trace the direction of the rays of light by which the skiagram was produced.

The localizer, being placed in front of the patient's eye, an exposure is made with the tube opposite the patient's temple; then, a second plate, with the light moved about *30* degrees from its first position.

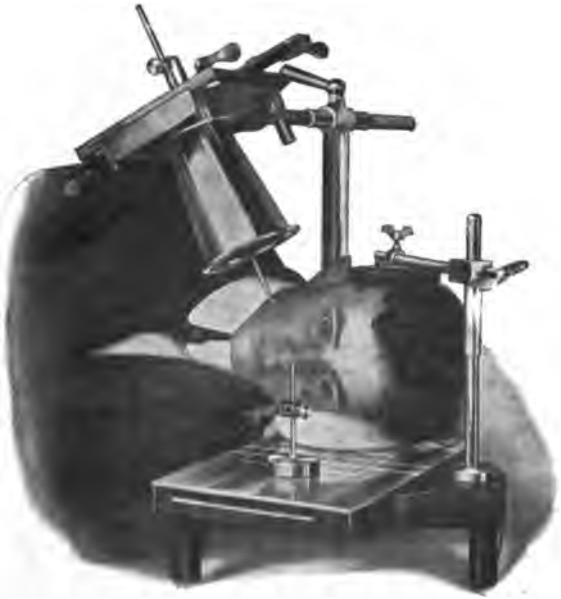
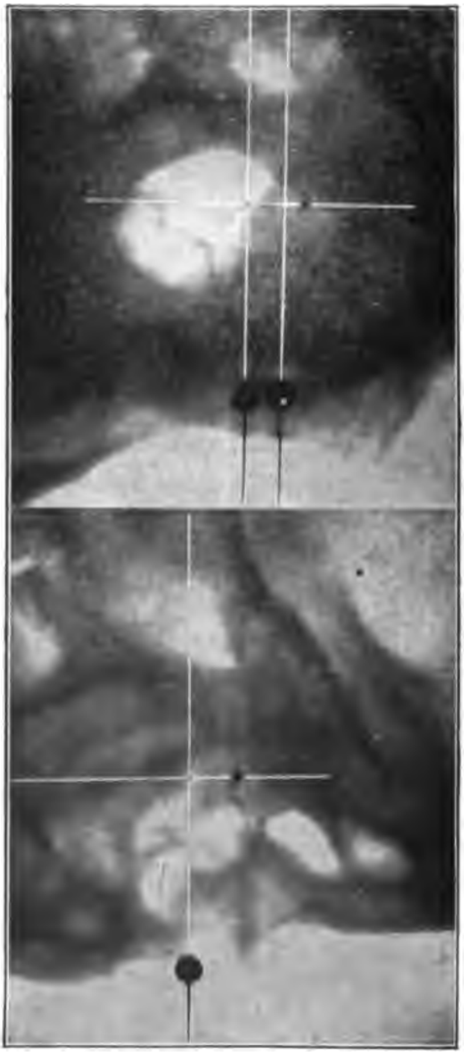


Fig. 64.—The Second Exposure.

The plates are then plotted on a suitable chart, the shadows of the indicator serving to determine the direction of the rays of light, and the position of the foreign body is graphically shown by the intercepting lines.



The Shot.

Fig. 65.—Skiagraphs Showing Foreign Body.

The Shot Localized.

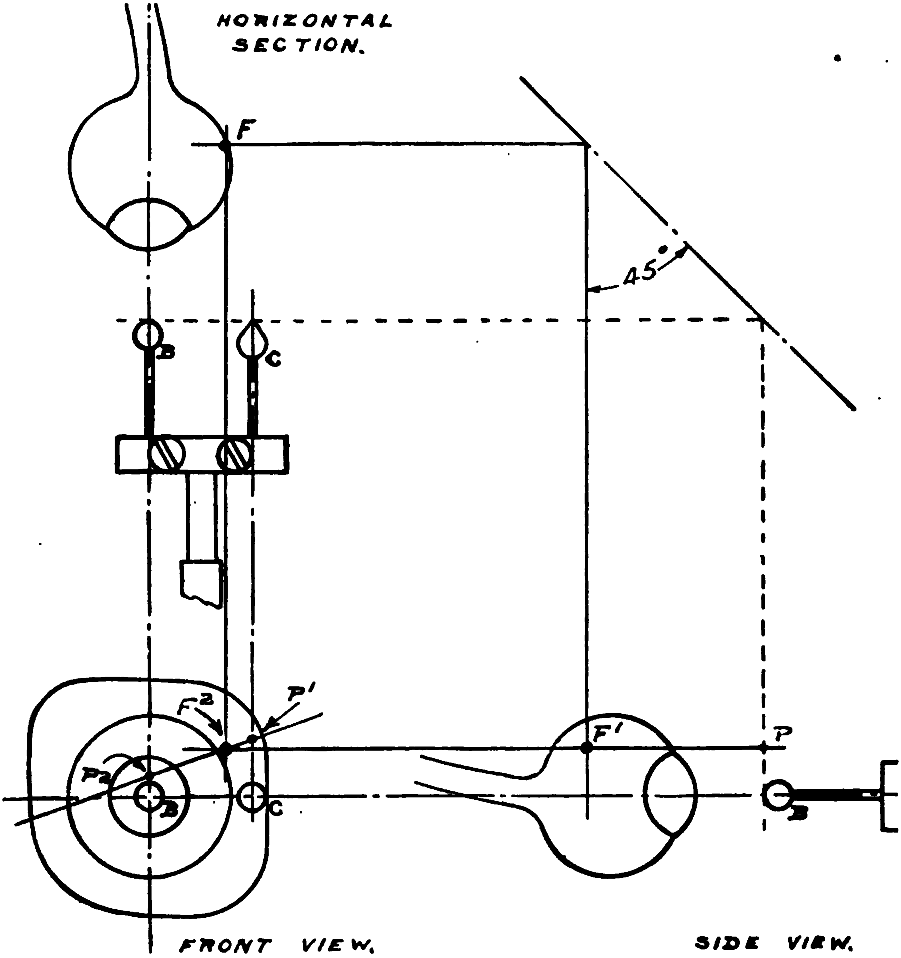


Fig. 66.—Diagram Illustrating Projection of Foreign Body.

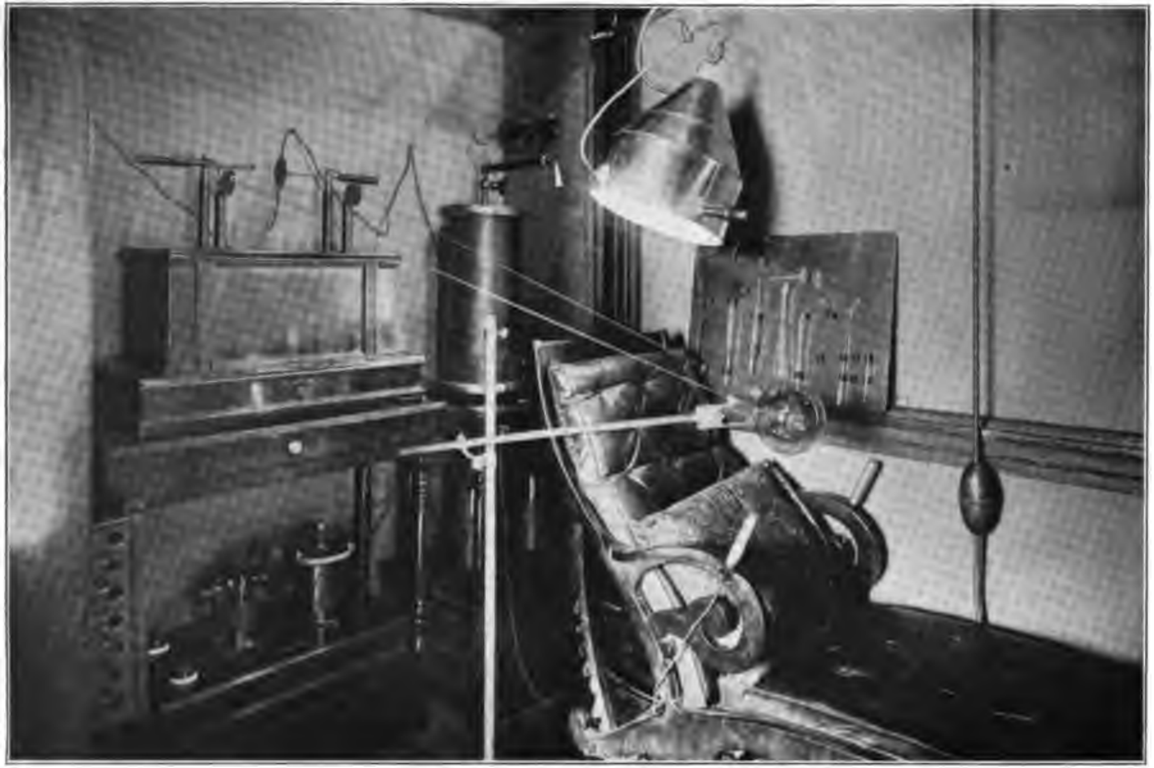


Fig. 67.—Treatment Room No. 1.

CHAPTER III.

THE AUTHOR'S EQUIPMENT.

As the author has had many inquiries as to the apparatus he personally employs, a brief description may not be out of place in the present volume.

The coil in present use is one of twelve inch spark-gap, provided with a mercury turbine interrupter for use in *x*-ray and high-frequency treatments, and an additional mechanical interrupter for breaking the current when the *x*-ray flash or high-frequency muscular contraction current is required.

Near the coil, but on a separate stand, is an Oudin D'Arsonval coil; and a couch which serves both for use in auto-induction treatments and as a rest for the patient who is being subjected to the effects of the *500* c. p. lamp, which is directly above it.

The current from the public mains enters on the left and, after passing through the meter, goes to the rheostat and from thence to the interrupter before entering the coil. A shunt or branch from the main wires furnishes the current needed to drive the motor that operates the interrupter.

A condenser, which is not shown in the diagram, is located in the base below the interrupter and is bridged across the terminals of the latter.

From the terminals of the secondary winding of the coil is shown the connection to the *x*-ray tube and the wires leading to the resonator, which is shown on the right of the diagram.

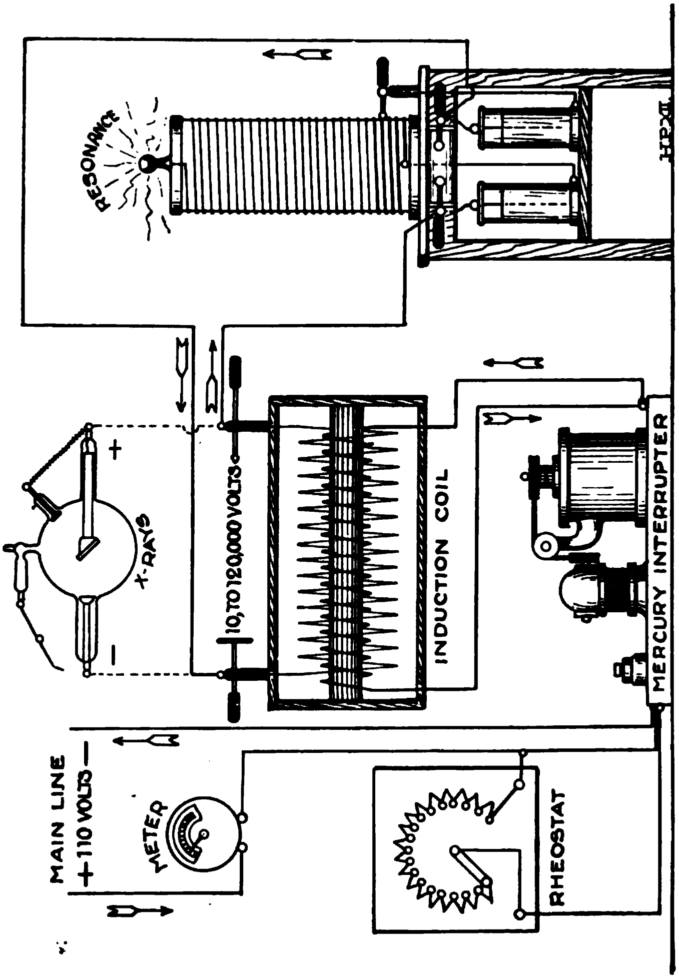


Fig. 68.—Electrical Connections of Apparatus Illustrated in Figure 67.

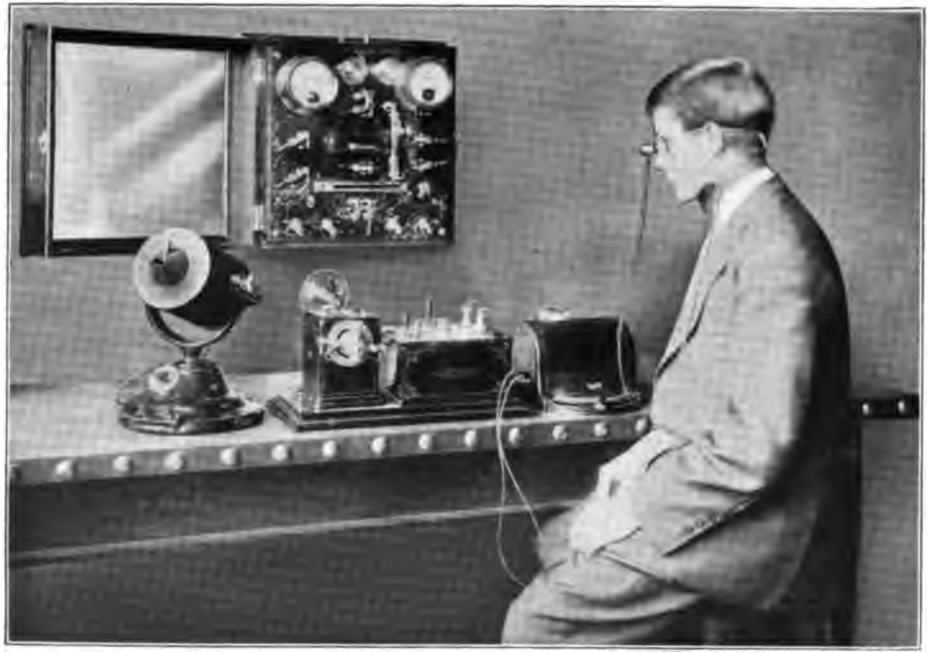


Fig. 69.—Treatment Room No. 2.

In a second room is a wall cabinet of the usual type, consisting of automatic rheotome, rheostat and pole changer, together with a faradic coil provided with both low and high speed interrupters.

On a shelf below the wall cabinet is mounted a motor-generator, designed to convert the *110* volt direct current, with which the office is supplied, into one of alternating character. To the left of the generator is an adjustable induction transformer, capable of giving the various currents required by cautery knives or diagnostic lamps.

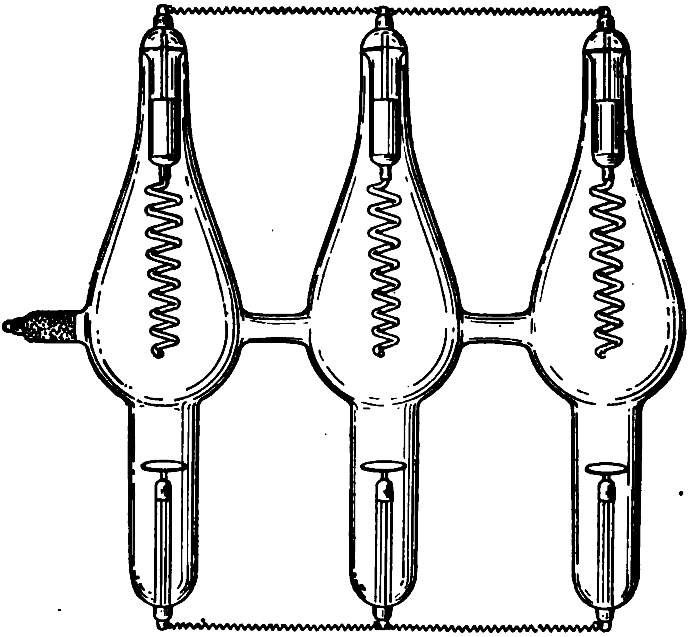
On the end of the shelf is mounted a rheostat to render the alternating current suitable for therapeutic purposes. As the alternating side of the generator is wound to give a simple type of harmonic wave and the speed being under direct control, the resulting current can be varied at pleasure to produce either a slow or rapid wave for sinusoidal treatments.

On the motor side of the motor-generator is a direct connected air pump for aural massage and an extension of the shaft provides a means of attaching a flexible shaft for operating nasal burs and trephines or a vibrator.

A giant magnet, located near a window, that affords the necessary light for eye cases, is a valuable accessory.

Part II.

The Therapeutic Use of Electricity and The Technic of Its Application.



A 3-Valve Rectifier to Prevent Reverse Currents of the X-Ray.

CHAPTER I.

ELECTRIC CURRENTS.

CHARACTERISTICS OF THE DIRECT CURRENT.

The polarity of the direct current is constant and the current itself unidirectional. It may be interrupted by a rheotome. In paralysis, this causes stronger muscular contraction than does the uninterrupted current, but the electrolytic effect is not lessened except in amount.

The amperage secured by the direct current is very high compared with the voltage used. Ten to one hundred and twenty volts applied to the body will give from two to two hundred and forty milliamperes, according to the resistance of the part.

In stating the strength of the current used, the size of the electrode is almost never mentioned; a most important omission, for the concentration of the current is directly the reverse of the area of the electrode: one of one inch square giving an intensity four times that of one two inches square.

When the intention is to secure the greatest interpolar effects on the tissues or system, this is accomplished by applying very large electrodes to the body, so as to diffuse the current over a large area, and thus avoid the painful and irritating effects which would result from condensing the same current upon a small area. Hence, abdominal electrodes, nine inches in diameter, are used in the Apostoli method of application of two hundred to two hundred and fifty milliamperes in treating uterine fibroids.

In applying the current to the eye, I prefer an electrode, single or binocular, two inches in diameter, of sponge covered copper, over which is placed absorbent cotton at each treatment. A soda solution, on the electrode, will lessen the resistance to the current and not corrode the copper, as would chloride of sodium. Eye cups, containing water or a salt solution *.06* per cent, make excellent electrodes, when it is desired to secure the greater effect of the current upon the cornea, by opening the lids, rather than by applying the electrode to the closed lids, as is usual. There is not so much irritation in a very sensitive cornea when the cup is used, as when a metal electrode is applied directly to the eye.

In opacity of the cornea, for example, a metal electrode (negative) with a current of one milliampere may be applied for one minute to a *quiet* eye without any reaction· By means of a cup, an *irritable* cornea may be treated with one milliampere of current with much less irritation, if any, than by the application of a metal electrode.

When the direct current is applied, in treating opacity of the vitreous, etc., I have abandoned the use of the cups, though they are excellent electrodes, because the contour of many orbits allows the water to escape. In treating the eye, I prefer to have the indifferent electrode oval and two and a half by three and a half inches in size,—and to apply it over the nucha. I hold the eye and neck electrodes in position by attaching to them elastic bands with tongueless buckles and buckling each firmly.

In optic atrophy, it may be better to apply the direct current in the manner Erb does; but, of late, I have used only the alternating or sinusoidal current in the disease. Erb first applies electrodes to the temples for a time, then reverses the polarity of the current and continues by applying the negative to the lids and the positive to the nucha; and, finally, the negative over the superior cervical ganglion and the positive on the nucha. Of these three, I think the first is the most important, still, the galvanization of the sympathetic nerve has so marked an influence on the eye, it deserves also a trial. Moreover, a variety of methods may secure a more faithful attendance of the patient,—an important factor in his relief. While it is usual for a daily treatment, given for a month, to decide whether a patient can be benefited, it does not follow that a patient, unrelieved by a month's treatment, may not improve in two or three months.

POLARITY OF THE CURRENT.

In treating the eye, the *cathode* should, usually, be made the active pole, on account of its stimulating, liquefying and other polar effects; while, the *anode* is made use of when its sedative, coagulative and other polar effects are required in headache, neuralgia, and in super-vascular conditions.

STRENGTH OF CURRENT.

When patients are very susceptible, and, in cases which require the sedative effect of the current, the dosage should be small,—as two to three m. a. to the eye for five to seven minutes. Most frequently, I administer five to seven m. a. to the eye.

DURATION OF CURRENT AND FREQUENCY OF THE TREATMENT.

It is customary to recommend very short treatments, to be given seldom,—twice to thrice weekly, at first,—then at longer and longer intervals.

Unless the convenience of the patients demands this, I consider it a waste of time and treat them daily, and, as a rule, for twenty minutes, for a month: and, then, perhaps, give them a short rest at monthly intervals. Possibly longer seances might be still better, but, judging from the nervous symptoms produced in some of my patients by the trial of it, I have concluded that the above time is wisest. When the case covers a long period of time, it is wise to completely intermit treatment occasionally.

After testing the tolerance of the patient, I see no more reason, in most cases, for the common practice of lessening the frequency of electrical treatment,—except with the *x*-ray,—than there would be in prescribing an alterative or tonic drug once or twice a week instead of three times a day. In chronic cases, my practice is to give treatments, with any form of electricity, daily.

The following report of the prolonged use of the current, by Dr. J. H. Kellogg, is valuable and unusual,—

"About twenty years ago, I conceived the idea of applying electrical currents of smaller quantity during a period of one to ten hours. It is convenient to bind the electrode to the affected part, and to allow the current to pass while the patient is asleep."

THE EFFECT OF THE CURRENT UPON THE EYE.

Holmgren discovered, in *1881*, that light, falling upon the eye, is transformed, in the retina, into an electric current. This demonstrates that a perception of light, light flashes or phosphenes may be produced by stimulating the retina with an electric current.

Roosa, Loring, Hackley and others have observed that both the retinal veins and arteries are enlarged by galvanic stimulation; and, Würdemann observes that this increase in size is still more marked after vibratory massage than it is after electrical stimulation and asserts that the latter does not reach further than the *papilla*.

The dizziness, cerebral hemorrhage and therapeutic effects on the brain, produced by a current, sufficiently demonstrate that the current does reach the brain.

If it were not so, *optic atrophy,* which, most frequently, originates extraocularly and is a descending process, would very rarely be relieved. My experience has, fortunately, shown that sixty-six per cent of these cases have been improved; and, others have demonstrated it in fifty per cent of cases.

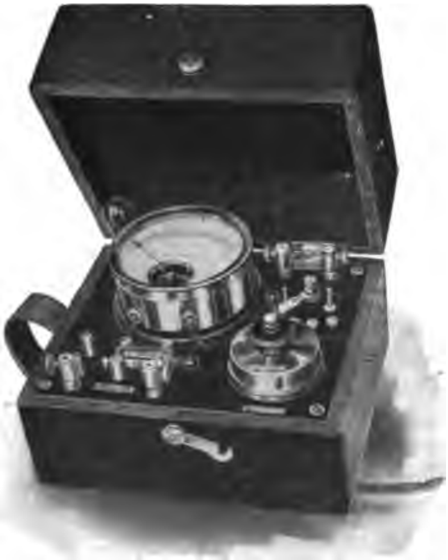


Fig. 70.—Portable Galvanic Controller. Meter. Pole Changer. Rheostat.

A few neurologists deny that these cases are benefited and say that, at any rate, the benefit is only temporary. It is true that, in certain cases, there is a tendency to deterioration, but any initial improvement argues favorably for still greater possibilities by a repetition of the treatment. What would the objector say to the statement that it is futile to treat chronic gastritis or a stricture, because it might relapse.

THE APPLICATION AND THERAPEUTIC EFFECT OF THE GALVANIC CURRENT.

When it is desired to administer to the patient the effect of the anode or cathode, the respective electrode is placed as nearly as practicable to the affected part and this is called the active electrode; while the other is the indifferent or dispersing electrode and is usually much the larger one. The direction of the current, through the patient connected in the circuit, is always from A. the anode to B. the cathode. With moderate dosage, it is immaterial on what part of the body this latter electrode is placed. If a definite milliamperage is desired, say 5, and the electrodes are placed far from each other, it will be necessary to use a much higher voltage in order to overcome the resistance than if the electrodes are placed near each other. The therapeutic result will be the same in either case and the degree of sensation of the patient is usually the same, though there are a few exceptions.

For instance, in the application of electrolysis with a single needle, with the indifferent electrode necessarily at a distance, the course of the current includes so large a distribution of the nervous system that it gives rise to uncomfortable sensations, such as dizziness or even syncope and pain; while, in the use of a bipolar needle, the current is limited almost to the region between the needles.

Formerly I stated, and I have seen excellent authority for the same statement, that a given current, say 5 m. a., produced by high voltage against a high resistance, would be more painful than the same current produced by a low voltage with a low resistance.

A medical electrician stated that he had proven, at least two hundred times, that a high voltage with a given current causes more pain than the same intensity of current produced by a low voltage. He admitted that, in each instance, he had suggested to the person that the above would be the case; which probably accounts for the supposed result.

In teaching, I demonstrated that when *100* volts were applied to five students, of *5000* ohms resistance each, joined in the circuit and subjected thus to a current of *4* m. a., each felt the same sensation as when one alone had applied to him *20* volts, with his resistance of *5000* ohms, giving the same current of *4* m. a.

With an initial supply voltage of *100*, each individual in the group uses up *20* volts; the same amount as each individual singly—and, consequently, receives the same milliamperage.

The fallacy of supposing that a high voltage, *per se,* produces more pain than a low voltage is due to the supposition that the voltage is the same throughout the circuit—which is incorrect, for no account is taken of the drop in voltage. That is,—the voltage is used up by every resistance it meets with and in direct proportion to the amount of resistance.

To illustrate this:—Let the dynamo furnish *100* volts and each resistance, *1*, *2*, *3*, *4*, *5*, persons or otherwise, be *5000* ohms each, the current will be $\frac{100 \text{ volts}}{5\text{x}5000 \text{ ohms}} = \frac{1}{250}\text{A.} = \frac{250}{1000} = 4$ m. a. in any part of the circuit.

Each of the equal five resistances of *5000* ohms will consume *1/5* of the total voltage or *20* volts: that is No. *1* will use up *20* volts, leaving *80*; No. *2* uses *20* volts, leaving *60*; No. *3* uses *20*, leaving *40*;

No. *4* uses *20*, leaving *20*; and No. *5* using *20* leaves zero at the negative terminal of the dynamo.

The connecting wires have so little resistance as to be neglible in the calculation.

If the initial voltage were the same in all parts of the circuit, each individual would have *100* volts and a resistance of *5000* ohms, consequently *20* m. a. of current, instead of *4*. Further, it is urged that at least the individual nearest the source of supply receives *100* volts. True, a hundred volts are supplied to him, but his sensation depends upon the current he receives, which depends upon the amount of voltage he uses up, which is *20*.

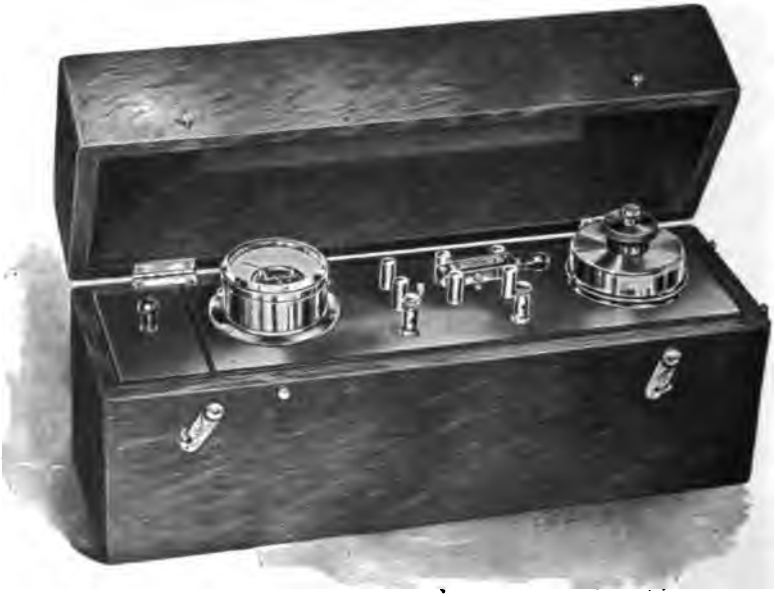


Fig. 71.—Portable Galvanic Battery, of Twenty-one Cells, With Rheostat and Millampere Meter.

ELECTROLYSIS.

While, in the past, it was considered that the nature of the attraction between the atoms forming a compound is chemical, Becquerel demonstrated it to be electric affinity,—in which conclusion, scientists now concur.

When an electric current passes through a solid metallic conductor, it does not produce any decomposition and it is not known that it produces any movement of the particles. On the other hand, in fluid conductors, the current produces decomposition and the particles by their motion, conduct the current. Electrolysis takes place only in fluids which contain acids, bases or salts. This solution is called an electrolyte.

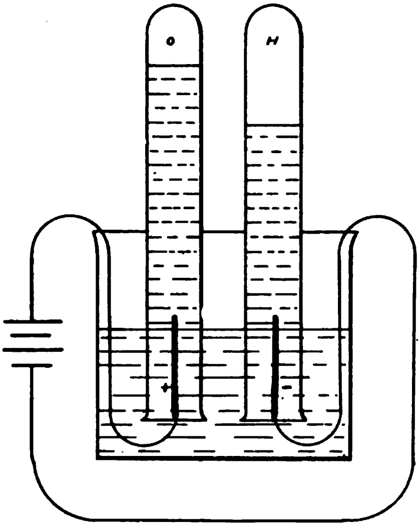


Fig. 72.—Figure 72 Illustrates the Electrolytic Decomposition of Acidulated Water.

Two non-oxidizable platinum electrodes, + and — , introduced into slightly acidulated water, in two inverted test tubes, will, when the current is turned on, decompose the water into two volumes of hydrogen, which will appear at the negative pole; and one volume of oxygen, which will appear at the positive pole.

Take, for instance, a solution of chloride of sodium. The current separates the chloride of sodium, by giving the sodium a positive charge, which makes it electro-positive,—and giving to the chlorine a negative charge, which makes it electro-negative. Hence, the particles of sodium are electro-positive or *cations,* since they move towards the negative or *cathode* pole; while, the particles of chlorine are electro-negative or *anions,* since they move towards the *anodal* electrode. Each of these charged particles is called an "atom of electricity." When these little travelers, ions, arrive at the electrodes, they give up their charges, and are free to form new combinations. Further, in electrolytic decomposition, oxygen, acids, chlorine, iodine, and bromine appear at the *anode,* and the metallic, the organic and the alkaline bases and hydrogen, at the *cathode.* These results are known as the *polar effects* of the direct current.

Althaus states that no animal tissue,—even bone,—can withstand the disintegrating effect of the direct current at the negative pole; and, that the amount and rapidity of the disintegration are proportional to the vascularity of the tissues acted upon, the strength of the current and the time employed.

As generally applied, it is not the purpose of electrolysis to produce suddenly, or even slowly, the death of the tissue in mass (*necrosis*); but, rather, to produce *necrobiosis*— or the death of individual cells which are surrounded by living tissue. There is, for example, so much misapprehension about the effect of electrolysis, that it is often said that the electrolyzing of a stricture produces such tissue destruction as to leave a still greater cicatrix than previously existed. I would like to designate, by some such name as *medical electrolysis,* a degree of current which does not produce necrosis as above defined,—and, by *surgical electrolysis,* a degree of current which does produce rapid death of tissue en masse.

The polar effects of the direct current upon the organism and the electrodes depend chiefly upon the nature of the chemical substances liberated at the poles. The most important compounds in the tissues acted upon by electrolysis are water and chloride of sodium, in solution. The oxygen and hydrochloric acid at the positive tend to produce a hard, dry eschar and to attack an oxidizable metallic needle or electrode. Also, they act, by their coagulating effect, as a hemostatic. On the other hand, the alkali base, at the negative pole, produces a soft and resilient eschar. The positive pole has a sedative effect upon the nervous system, while, the negative acts as a stimulant.

The electrolytic effect of a current is in proportion to its amperage; hence, it is very great in the direct current and almost negligible in the static, high frequency and faradic. In the mono-polar method of electrolysis, the needle or needles to be used with the negative pole, may be made either of steel or platinum. To avoid corrosion, the needle or needles used with the positive pole, or the needles used in the bipolar method, should be of platinum, or, preferably, of platinum irridium. The street current *(direct)* is the most convenient source of energy, but a chemical battery of thirty or more volts will suffice.

"Fibroids and other more compact tissues are acted upon less rapidly, while, adenoid tissue is readily electrolyzed. Enchondromata are but slowly affected by electrolysis, and its influence on osteomata and bony tissue is so slow that the electrolytic effect is disputed by many writers." (Scheppegrell.)

Apostoli and others found that staphylococcus aureus was destroyed by sixty milliamperes of current in fifteen minutes; staphylococcus pyogenes by sixty to eighty milliamperes; anthrax bacillūs by two hundred and thirty milliamperes in thirty to sixty minutes.

ELECTROLYSIS AND ITS THERAPEUTICAL APPLICATION.

Dr. Robert Newman writes:—

Electrolysis is the decomposition of a compound body by electricity—a chemical decomposition—or the separation of a chemical compound into its constituent parts or elements by the galvanic current. The body to be decomposed must possess certain elements to be an electrolyte, and as a compound body must contain water and a salt.

Laws of Electrolysis.—(*1*) Electrolysis cannot take place unless the electrolyte is a conductor (electric). (*2*) The energy of the electolytic action of the current is the same, whenever exercised, in different parts of the circuit. (*3*) The same quantity of electricity—that is, the same current for the same period—decomposes chemically equivalent quantities of the bodies it decomposes. (*4*) The quantity of a body decomposed in a given time is proportional to the strength of the current. (*5*) A definite and fixed electro-motive force is required for the decomposition of each compound.

Nicholson and Carlisle discovered this process of electrical decomposition in the year *1800*, and electrolyzed water into oxygen and hydrogen.

The action of the poles being very different in electrolysis, each has its own function. The negative pole acts like a caustic alkali, which does not hurt during the application, and leaves, if carried to excess, a cicatrix that is soft and retractile. From this, it is evident that for the immediate destruction of *tumors* and for *strictures* the negative pole should be selected. Electrolysis requires the presence of water, and that you will find in every tissue of the human system.

As it is most important to distinguish the poles, and as we cannot trust to the marks of the instrument-maker we must always ascertain which is the positive, and which the negative pole.

The specific action produced by electrolysis in the treatment of stricture has received different names. This diversified nomenclature has produced considerable misunderstanding, and time has done little to remove the confusion and obscurity in which the action of electrolysis is still involved. Dutrieux calls it electrochemical cauterization. Dittel names it a chemical galvanocaustic. It seems that all who have written and experimented on the subject mean the same thing, but express it differently. This diversity in the nomenclature has provoked the criticism of the editor of that special department in Virchow's "Yahresbericht." Dutrieux, he says, depends for the action of the electrolysis on the caustic effects of the negative pole, which leaves a soft and retractile cicatrix, and wonders that Newman relies on chemical absorption as an effect of the electrolytic action.

That the same thing is meant is evident from the previous statement, as well as from the description of the *modus operandi* by Mallez and Tripier, who lay great stress, and rely on the chemical and not on the caustic effect that would result from the application of the positive pole or the approximation of the two poles. With such a definition, which is taken from Mallez and Tripier, why the French surgeons call the action "par la galvano-caustique" cannot be understood.

The uses of electrolysis are manifold and many have been described by my late friend W. E. Steavenson, M. D· (Cantab))in his book published by Churchill in Lindon in *1890*.—

The list comprises: Naevi, carcinoma, exophthalmic goitre, goitre, granular lids, wounds and ulcers, port-wine marks, angioma, naso-pharyngeal disorders, fistulae, fungoid growth, ingrown eyelashes, keloid scars, moles, strictures of the eustachian tubes, lachrymal canal, tumors, ranula, blemishes of the face.

The electrolysis should be applied with weak currents in order to absorb, and never to hurt, burn or cauterize or destroy tissues. If indicated, an exception to this rule may be made for good reasons. Seances must be made at intervals.

Newman says:—"My method not to hurt, burn, etc., has not been comprehended by some members of the medical profession. I have practised elctrolysis now for thirty-five years, with success, in many thousand cases — have published many papers, have for most cases documentary evidence, and the statistics have been investigated and found correct by a committee of eminent surgeons. One of these papers has been published on page *40* of the Trans. of the Am. Electro-Therapeutics Ass. of *1893*."

CATAPHORESIS.

Cataphoresis is derived from "katapherein," to bring toward, so called because the drugs introduced into the system through the skin or mucous surface, by means of ointments or solutions applied to the positive electrode, generally are electropositive or cations and move *toward* the negative pole.

Anaphoresis, on the other hand, refers to those substances which, applied to the negative, move *from* the negative toward the positive pole.

Scheppegrell defines cataphoresis as "the property of electricity of diffusing fluids and substances through other fluids and substances." The process is also known as "electric transportation" and "electric medicamental diffusion"—a most graphic definition. The process is not only analogous to electrolysis, but is the same in kind. Its application differs, inasmuch as in cataphoresis the electrical decomposition occurs in the medicament applied to the electrodes; while, in electrolysis, the action is in the tissues.

Leduc settled, dramatically, any doubts as to the fact and nature of polar effects upon the body, in introducing drugs into the body, by applying a solution of strychnia sulphate and a solution of potassium cyanide, on an electrode, to the bodies of dogs. When strychnia was applied on the positive electrode, with the indifferent electrode on another part of the body, the dog died in convulsions. The strychnia applied on the negative electrode produced no symptoms. The cyanide, applied by means of the negative electrode, caused the toxic symptoms of hydrocyanic acid and death: applied by the positive pole, no symptoms developed.

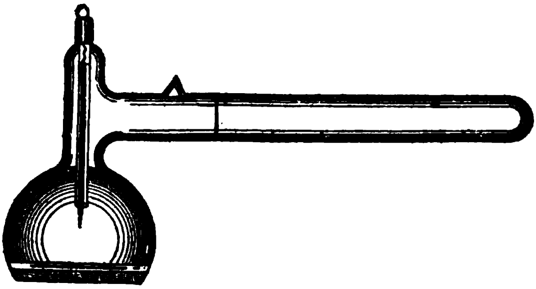


Fig. 73.—High-Frequency Cataphoric Electrode.

The above strikingly illustrates the law of ionization. A salt, used for treatment, would be decomposed, if applied by either pole; but, if the effect of a base, such as strychnia, cocaine, morphia, zinc, iron, etc., should be desired it should be applied by means of the anode, as it would penetrate the tissues seeking the cathode, for which it has an affinity and leave the repulsive anode. If it is desired to administer an acid, as hydrocyanic or hydrochloric or iodine, it must proceed from the cathode application to the anode.

THE DIFFUSION OF IODINE BY THE ELECTRIC CURRENT.

Dr. M. F. Wheatland of Newport, R. I., says: —That there is a divided opinion in the profession as to the pole to be used in the diffusion of iodine by the electric current is evidenced by the following expressions quoted from various sources. In the Transactions of the American Electro-Therapeutic Association for *1896*, Dr. Massey said an excellent way of employing iodine was by the application of iodide of potash to the negative pole.

Dr. Stephen H. Weeks said that he had been in the habit of using the iodide of potash solution on the *positive* pole for cataphoresis.

On page *365* of the "Treatment of Diseases by Electric Currents," by S. H. Monell, we find the following method for the use of iodine: "Moisten a felt-covered, flat electrode, and connect it with the negative galvanic pole. Wrap a light layer of absorbent cotton around the spiral electrode, connect it with the *positive* pole, dip the cotton in the iodide solution and insert it as desired."

Dr. Peterson in "International System of Electro-Therapeutics," (Page *345*), thus expresses himself: "For such cutaneous disorders as are commonly treated by painting with iodine, the use of some of the iodide preparations such as potassium, sodium, or lithum iodide, iodol or dilute tincture of iodine upon the *anode* is indicated."

Such is our state of mind as to the use of one of the most important remedies in the pharmacopeia.

After doing much experimental work, I have been fortunate in securing the "Outlines of Electro-Chemistry," by H. C. Jones of John Hopkins, and after a careful perusal of the same, it is safe to say that there is no reason for the belief that iodine can be projected into the tissues by the *positive* pole.

If the conclusion that elements move from pole to pole according to their electrical quality be correct, then the assumption that one pole is a diffusible pole, regardless of the element to be diffused, is a fallacy. I say this because there seems to be a general impression that the positive pole is the diffusible pole under all circumstances. I presume this impression gained ground because of the common use of the metals, silver, gold, mercury, zinc, and copper, which are positive elements (cations) and necessarily move to the negative pole when connected and subjected to the action of the continuous current.

Owing to the slowness with which iodine is diffused from an iodide, when it is desired to obtain the action of this element on the tissues, it seems more expedient to use a solution containing free iodine—such as Lugol's—one in which there will be a large quantity of the element to be acted upon by the current: a fifty per cent. Lugol's sol. answers well. When we consider that iodine is indicated in the conditions which suggest the use of the negative pole, a great advantage must come to those who in such cases properly combine the two remedies electricity and iodine."

A very simple experiment may be made to determine upon which pole iodine should be placed, in order to introduce it into the body. If a solution of iodide of potassium be poured upon a piece of starched paper, and the two electrodes of the direct current be applied to the paper, the salt will be decomposed and a blue iodide of starch will appear at the positive pole, while, at the negative pole, litmus paper will show an alkaline reaction, due to the potash.

This demonstrates that in the electrical application of iodine to the body, the iodine will move *from* the negative pole into the tissues toward the positive pole.

Burci and Fraseani found that iodine, applied to the negative electrode, with five to ten m. a. for fifteen to thirty minutes, killed both streptococci and staphylococci by the nascent iodine liberated at the positive pole.

METALLIC ELECTROLYSIS.

By this is meant the electrolytic effect upon the electrodes themselves, such as steel, zinc or copper needles. If a zinc needle, for example, which is much used in the treatment of tumors, be made the positive electrode, the oxygen and hydrochloric acid, furnished by the electrolization of the solution of chloride of sodium in the tissues, attack the zinc and form an oxychloride of zinc. This, we can conceive as being again decomposed, and the zinc liberated to seek the negative pole, and thus act upon the tissues at some distance from the needle. The usual explanation is that the oxychloride of zinc, in its nascent state, flows toward the negative pole.

W. J. Morton, of New York, as a result of his study of metallic electrolysis, offers four conclusions:

1. The salts of many metals, such as zinc, copper, mercury, etc., may be electrically dissolved from metallic electrodes and made to permeate human tissue. In applying the same current to dead tissue that he did to living tissue, he noticed an apple green color half an inch or more from the copper electrode.

2. The electrically formed and the electrically diffused metallic salts are not destructive to tissue, in the sense that ordinary electrolysis is. These salts produce nutrition of the diseased tissues and promote their absorption.

3. These electrically formed salts possess an elective affinity for diseased in preference to healthy tissue.

4. Electrical diffusion is greatly superior to topical applications, for the medicament is caused to penetrate the tissue acted upon.

THE THERAPEUTICS OF STATIC ELECTRICITY.

In a personal communication on *therapeutic influence of the static current* Dr. C. H. Treadwell, of Chicago, writes:—"I regard the *static machine* as offering two general and distinct effects on the nervous system; *a,* sedation, *b,* stimulation. These effects are directed primarily upon the peripheral nerves; but, these, in turn, act upon the central nervous system. Both sympathetic and cerebrospinal nerves can be affected by static treatments.

Sedative Treatments.—1.—Positive head breeze. Let any one take such a treatment, properly applied, and he will agree as to its efficacy. The crown or other pointed electrode should be at such a distance, that the patient will feel only the slightest electrical breeze. Every practitioner should determine the distance by turning it on himself, having some assistant adjust the electrode.

2. Dr. Neiswanger's Modification of the Morton Wave. Apply a large pad electrode or a long block tin electrode, from the + prime conductor, directly upon the spine, separating the balls on the prime electrode from 2 to 5.5 inches. Dr. N. uses the jars, and I believe it very necessary to use a spark muffler to deaden the noise.

Stimulating Treatments. — 1. *The negative head breeze.* Double two or three layers of flannel upon the patient's head and adjust the crown at a height of from 6 inches to 2 feet, depending on the output of the machine. Any one can tell at once that this is a stimulative treatment.

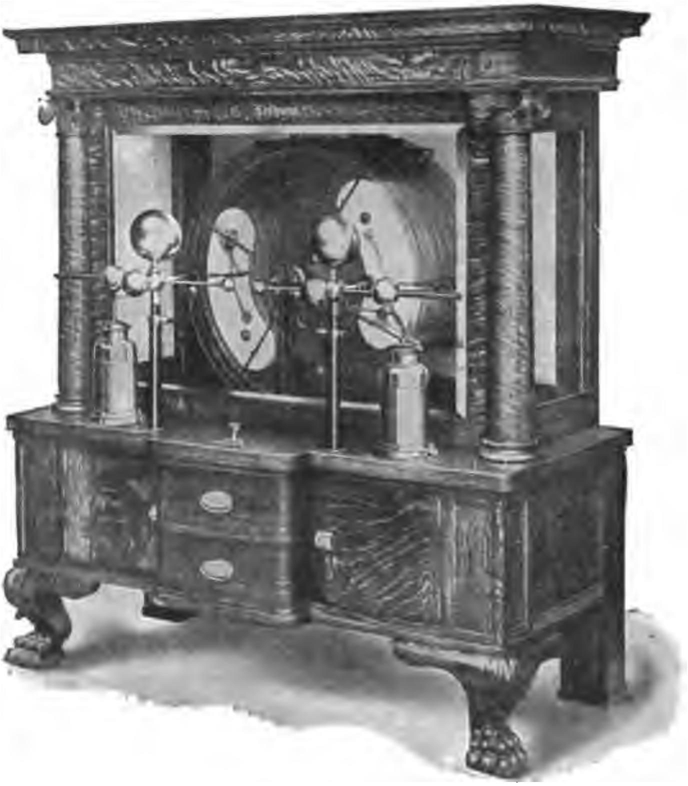


Fig. 74.—Static Machine.

2. *The Static Spark.* This is too painful, generally, when given on the thinner parts of the body.

The spark often does much harm because it is given when sedation should be administered.

3. *The Morton Wave,* when given from the negative prime conductor, applied as stated before, only using a smaller electrode. The negative charge insures stimulation.

I believe, Doctor, that your method of using Leyden jars, connected to a large coil machine, affords the same opportunity of treating cases for positive or sedative and negative or stimulative treatment, but I have never had the opportunity of trying it out on clinical cases."

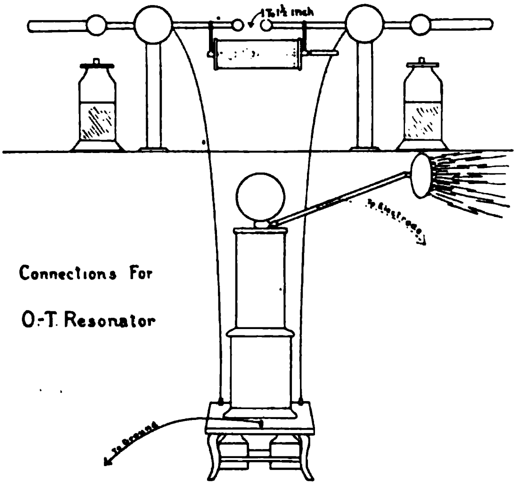


Fig. 75.—An Oudin Tesla Resonator for Obtaining High-Frequency Currents From a Static Machine.

THE TESLA APPARATUS.

The Tesla coil is now in such general use that the principle of its action merits a brief description.

The apparatus devised by Tesla for the production of currents of extremely high tension consists essentially of an initial source of supply capable of giving a current of ten to thirty thousand volts; a mechanical interrupter of very rapid action; a condenser and a transformer of special design to still further raise the potential of the current. It is to this transformer to which the special name of "Tesla Coil" is usually applied.

The particular features of the Tesla coil are two concentric solenoids, the relative windings of which are proportioned to the initial current voltage and the voltage desired.

On account of the residual magnetism preventing a rapid change in the lines of force, an *iron core is not used;* but, instead, the diameters of the coils are such as to oppose the least resistance to an *aerial path* for these lines.

For moderate voltages of medical coils, air is used as the dielectric; and oil, when operating at high voltage· The reason a liquid is used in place of a solid dialetric is in order to prevent a spark passing from one coil to the other.

For medical purposes, small coils of the Tesla type are in use in connection with the static machine or *x*-ray coil to increase the frequencies of these machines and they are often supplied as complete equipments when high-frequency currents alone are required.

Most, if not all, of the portable high-frequency machines are of the Tesla type and consist of an interrupter, a step-up transformer, a Tesla high-frequency transformer and the necessary condensers.

PHYSIOLOGICAL EFFECTS OF FARADISM.

The action of the *faradic* current upon the central nervous system and distant organs is slight compared with that of the direct current, and the muscular contractions it produces are painful, as compared with those caused by the sinusoidal. The negative pole stimulates the sensory and motor nerves much more strongly than does the positive.

Debitat attributes the results to the local gymnastic action on the muscles, which increases muscle growth; and cites twenty treatments, of four minutes each, as increasing the weight of the femoral muscle of an animal fifty per cent., while prolonged application diminished weight, tetanized the muscles,—and, when extreme, resulted in atrophy. The tetanized muscle, when fatigued, relaxes. When the interruptions of the current exceed *10,000* per minute, the muscle is tetanized, and no longer responds to the current.

Can An Electric Current Excite Muscular Contraction Independently of Its Nerve Supply?

Claude Bernard proved that it can,—by introducing Woorara into the leg of a frog, until it showed no signs of life, and the galvanic current was applied to the lumber nerve without causing any muscular contraction. Applied to the muscle, it at once contracted.

A healthy muscle contracts more readily under a faradic current than under a galvanic. In *paralysis,* contraction of a muscle is more readily affected by an interrupted galvanic than by a faradic current.

Beard and Rockwell explain this as follows:—"Muscular fibre, in disease, undergoes degeneration that makes it incapable of responding to the electric influence as rapidly as in health. Now the interruptions of the faradic current are exceedingly rapid, and they do not give the diseased muscle sufficient time to contract under its influence. The interruptions of galvanism may be made *slowly,* and, therefore, give the muscles time to contract.

In healthy muscles, the interruptions of the galvanic current are not made as rapidly as is necessary to bring out their full contraction; while, the interruptions of the faradic current are exceedingly rapid, though, no more so than the healthy muscle requires. The power of the galvanic is probably also due to its greater chemical properties; and, this, in turn, to its longer continuance of action. Trousseau caused an elevation of temperature of 4.4° C. by a treatment of ten minutes."

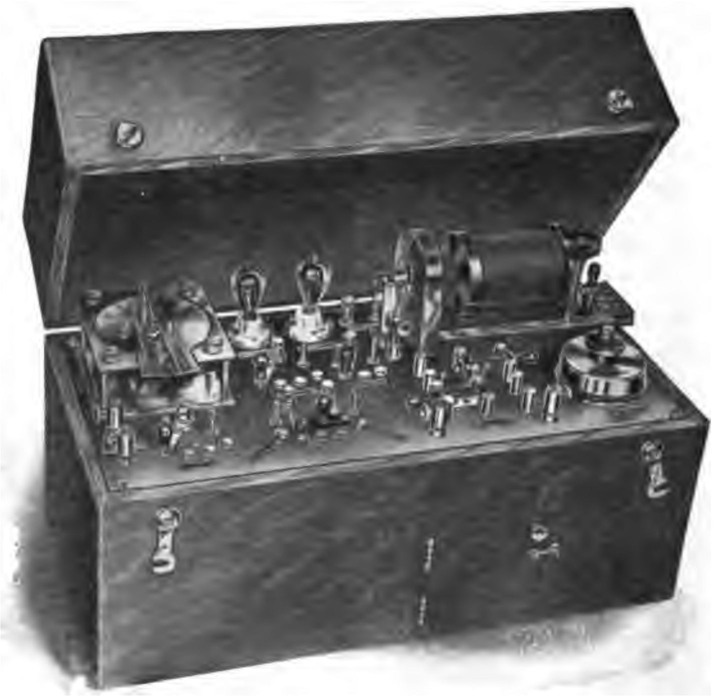


Fig. 76.—Combination Portable Englemann High Tension, the Faradic and the Galvanic—With an Automatic Rheotome—To Operate With the Direct Current.

The stimulation, by faradism, of the voluntary and vaso-motor muscular fibres, doubtless increases the circulation, and, thereby, produces metabolic and tonic effects.

PHYSIOLOGICAL EFFECTS OF THE HIGH FREQUENCY CURRENT.

With the *high frequency* current, the patient is unconscious of any sensation or muscular contraction, the vibrations of the current being too high (above *10,000* per second) to induce sensory or motor reaction. D'Arsonval, by passing a current through a saline solution in a cylinder and finding it as strong at the centre as at the periphery, demonstrated that the current *does pass through the body* of the patient. The trophic changes produced by the coil are greater than those produced by the static machine. (Guilleminot). This is probably due to the greater amperage of the coil, to which ionization is proportional.

Administered by means of the auto-condensation chair or couch, the patient receives a current of great potency without the slightest discomfort. The spark light kills all kinds of bacteria on the surface in a few minutes. The head breeze is a current of electrified air molecules. It has a very sedative action and relieves pain.

The zinc plate of the couch is one coating of a condenser, the cushion is the insulator or dialectric (dia, through), and the patient the other coating. Local sparking causes muscular contraction, rise of blood pressure, and anaemia, followed by relaxation, fall of pressure and hyperemia. D'Arsonval says "The carbonic acid of respiration is increased one hundred per cent and heat doubled by this current."

The coils made ten years ago do not give a muscular contraction, that is a Morton Wave current—the make and break of the interrupter being too rapid.

I obtained a mercury dip interrupter and a rheostat to control the speed of the interruptions and connected them, when required, with the coil circuit—the jet interrupter being switched off. This gave ideal contractions. Of late, in lieu of these, I have had my wall rheotome adapted for interrupting the high frequency current, and generally apply one to two hundred interruptions per minute, when using it to contract the tensor tympani muscle and to secure effects in chronic deafness,—also, to get interrupted *x*-ray flashes.

I use the auto-condensation couch in local and general neurasthenia and in cases of high blood pressure. The urine salts increase, metabolism and absorption are promoted and nutrition is improved by its use· Voluntary and involuntary muscular fibres contract increasing the vaso-motor and general circulation and body weight.

The weight of Oxygen absorbed in the respiratory exchanges is greater than the carbonic acid eliminated,—hence, there is an increase of body weight. The ozonation of the oxygen renders it the more absorbable by the red blood cells. D'Arsonval's experiments have shown that the amount of heat given off by the body is nearly doubled and that the current augments the quantity of urine, urea, uric acid and urine salts, and that this increase continues for several days; at the same time, there is a decrease of the non-oxidized sulphur compounds.

After testing the susceptibility of the patient by five-minute treatments on the couch, I usually find twenty minutes well borne.

In chronic deafness, I drop warm water into the ears, then insert moist cotton cones and place over them pads of wet cotton, to which the tips of a metal binaural are applied. A single cord connects the electrodes with the positive prime conductor, the rheotome being in circuit, and the current is very carefully turned on; the patient having been directed to hold up one hand when the current is felt, and both hands when as much is felt as can be comfortably borne. Treatments are repeated daily, by preference, or tri-weekly, for ten to twenty minutes.

For treatment of eyes, head and neck, I have chiefly used vacuum electrodes, connected with the top of the resonator. In neuritis and neuralgia, ocular pain and headache, only the slightest fluorescence of the tube should be produced, by placing the rheostat low on the resonator, and regulating the spark-gap of the jars, while the electrode is held in place by the patient. Treatments are given daily for ten or fifteen minutes.

I know of no drug or electric modality that is so certainly and so highly efficacious, in cases of this character, as is this *high frequency* application. Both the general and the local treatment are usually given in sequence, at the same seance, if both are indicated.

DOSAGE OF THE HIGH-FREQUENCY CURRENT.

There appears to be no limit to the tolerance of this current, if the interruptions be sufficiently high. Tesla, with his body in the circuit, lighted ten sixteen candle-power lamps, which require five amperes of current. On the contrary, with one third of an ampere, a galvanic current may kill a man.

THE COIL VERSUS THE STATIC MACHINE.

For the past ten years, I have urged the superiority of the *coil,* for every purpose of which the *static machine* is capable. The coil occupies, relatively little space, requires little care, works well in all weather, and, unlike its fickle predecessor, is constant in its polarity. It also furnishes sufficient amperage to charge the chair or couch. The greater utility of the coil in radiography is unquestioned and it also produces greater trophic effects,—which are probably due to its higher amperage.

The static machine has the advantage that any motive power can be used to run it when electrical power is not available.

Treatment by the auto-condensation couch gives more rapid results than by the auto-conduction cage, which is rarely used in America.

ACTION ON CELL LIFE. MICROBES AND TOXINS.

Observations show that the virulence of toxins, within the body is diminished by the use of the high-frequency current. Microbes are probably not killed, although they are inhibited and grow less rapidly.

The changes in metabolism and the increase of nutrition are probably largely due to the stimulating effect of the high vibrations, which are communicated to the trophic nerves.

Dr. Adolph Henriques, of New Orleans, writing of the "Physiological Action of High-Frequency Currents," says: "The end of the resonator is connected with a metallic electrode, usually pointed. If we project long sparks upon the skin for a prolonged time, a blister is produced, and finally, a slough is formed. If sparking occurs upon the surface of a wound, there is a discharge of serum very quickly. In two to four days, the serum thickens and becomes purulent during the elimination of the slough—if there is any. A spark of several millemeters is rapidly anaesthetic; sparking at two to three centimeters, is very painful."

Effects of Effluve or Waves.—The intensity of action of the effluve is much less marked than that caused by sparking. An aigrette or number of points is used instead of a single point. The skin and blood pressure regain their normal tone, usually in several hours, after alternating dilatations and contraction of the vessels.

Effect of Condenser Electrodes.—These are usually of glass, within which is a cylinder of metal, acting as the internal coating of a Leyden jar. The skin represents the other coating. By induction, small sparks strike the skin. Their effect is similar to that of the effluve, but can be applied with more precision.

Direct Contact With Metal Electrodes or Variously Shaped Vacuum Tubes.—They act similarly to, but less powerfully than, the effluve. They cause vascular contraction, which is shortly followed by a hyperaemia.

Dr. Frederick Finch Strong says,—"The local effects of the resonator discharge result not only from the action of the *high frequency current* itself, which increases the cellular and chemical activity of the superficial tissues, but by the bombardment of the surface of the body by the rapidly moving ions which constitute the spark or effluve discharge; from the action of the ether waves generated by the vibrating electron; and from the germicidal action of the ozone which is liberated by the electrical vibrations.

"Brush discharges are given off by metal points while rounded surfaces produce sparks or arcs.

"A single brass point electrode, one consisting of a number of points in the same plane,—a fan-shaped brush of fine wire and a single point projecting from an insulating glass tube,—forms an efficient equipment for the application of the effluve."

HIGH-FREQUENCY CURRENTS.

The Fulguration (Effluvation) of Malignant Tumors.—In answer to the question as to what distance from the tissue the electrode should be held, Dr. Kurt Schultze, of Berlin, says that the action upon the tissues does not depend on the length of the sparks but on the intensity of the current at the moment when the sparks pass. With his apparatus the maximum was reached when the sparks were just over one centimeter in length. He also states that by gradually bringing up the electrode to a distance of one centimeter from the skin both the pain and the caustic action were sensibly decreased.

Care should be taken to direct the sparks to the region to be treated, as the sparks are apt to jump to the edges of the wound.

He further states that where it is impossible to radically extirpate the whole of the carcinomatous tissue with the knife, he has used effluvation and curettage alternately, as recommended by Keating-Hart, and has found with him that, after sparking, the tissue is necrotic, softer and more easily removed.

Histological examination shows that fulguration exercises a superficial escharotic and necrotic action on the superficial tissue. This extends only over a layer from one-half to one centimeter in depth, and in this area the carcinomatous and the normal cells are equally destroyed. There is no visible effect on the deeper layers, nor is there any apparent special or selective action on carcinomatous cells, or any evidence of deeper action. In all cases where carcinomatous tissues were left behind after operation we were disappointed in the hope of destroying or even weakening its malignancy.

The writer's observations are adverse to the employment of the method in connection with operations for carcinoma.

Writing on this same subject, Dr. J. A. Rivière, of Paris, France, says:—Amongst the physico-therapeutic agents whose action is the most remarkable, I must, above all, point to high-frequency and high tension effluves and sparks. The regulation of their activity is pretty easy, according to the case. I preferably employ the long currents and the bipolar sparks when it is necessary to act on tumors deeply situated, reserving for epitheliomata the monopolar applications.

I was the first to assert that which has since been confirmed—namely, that the high frequency effluves and sparks cure both superficial and deep malignant tumors; that they destroy the neoplastic masses, whilst they respect the healthy tissues; that their action on lymphoid tumors is most marked; that they should, in conjunction with the Roentgen rays, when employed after operations, serve to prevent the recurrence of malignant tumors; that physico-therapy is the one and only resource in cases of inoperable tumors; that the strength of the Roentgen rays can be very great without producing impairment of the tissues; that occasionally the actinodermatitis seems to hasten and to favor the cure; that it is indispensable to push the treatment as far as elimination of the necrosed parts, that the neoplastic cell does not derive any benefit from the synergic forces of the healthy cells under the influence of the nervous system; that it is always necessary to pay great attention to the patient's general condition, as well as to the treatment of the local lesion; that in the presence of a disease as tenacious and grave as cancer, the medical man should know how to accommodate the power of the treatment to the resistance of the disease, and also to bring judiciously into play all the resources of the physico-therapeutic armamentarium.

Since that period, without abandoning the use of the Roentgen rays, but faithful to my first convictions, I have within the knowledge of my colleagues, given the first place in treatment to the high-frequency effluves and sparks as being more reliable and more conclusive. However, according to my usual method, I regard as legitimate (and going still further, as indispensable) the therapeutical alternation and super-position of the various physico-therapeutic agents in order to obtain a cure. This cure, thus considered, terminates, even in the most hopeless cases, in a lessening of the pain, in resolution of the tumor, in improvement of the dyscrasic condition, in re-establishment of the nutritive equilibrium. I have not thought it necessary to employ chloroform and the curette, as later on, my confrère Dr. Keating-Hart has done. The apparatus I have used, all differing in their mode of production and in their intensity, are the best and the most powerful made up to the present date, and I have always maintained that the patient can bear without pain the longest effluves and sparking, on condition that these last are not too strong. Those high-frequency sparks and effluves, the different productive arrangement of which allow of variations in their application, are the ones which exercise an elective action on the neoplastic cell.

Fig. 77.—Dieffenbach Adjustable Fulguration Electrode.

Between the spark and the effluve there only exists a question in degree of concentration in the strength of the high frequency. The effluve is a spark divided into more or less fine rain-like spray; it is emitted from an electrode bristling with points, whilst on the other hand the spark is given off from one point only. The effluves and the sparks, thanks to the perfected apparatus I have made use of, can be short or long, scarce or in large numbers, fine or dense; for this, it is merely necessary to alter the working of the apparatus. An even better plan is to have at one's disposal, as I myself have, several apparatus of different construction. There are various shades of dissimilarity between different sparks and effluves, according to whether they are short, fine, long, or dense. The short, warm sparks of great strength are the ones that exercise the thermo-electro-chemical action. They destroy the neoplastic masses, and their action proceeds from the periphery to the center. These sparks, which are derived especially from the small solenoid or even from the primary part of the resonator, cause pain. The long sparks and effluves act by percussion, and their effect is deep. Their action from a certain distance is necessary for the disorganization of the deep neoplastic cells. The short sparks of the small solenoid act specially by their amperage. The long effluves or the sparks of the secondary part of the resonator act, above all, by their voltage which can attain *300,000* volts, or *600* watts.

High-frequency currents, by preventing the precipitation of urates, by favoring elimination and complete combustion of nitrogenous matter, cut off, as it were, the supplies to the cancerous process, thus preventing the organic cells from taking on karyogamic proliferation, the great abettor of neoplasms and of the most serious neo-organisms.

From his wide experience, Dr. Rivière has drawn the following conclusions:

(*1*) It has always seemed to me that high frequency currents, in the form of effluves or of mono or bi-polar sparks, enjoy the property of having the most trustworthy, the most continuous, and the most penetrating, modifying action on neoplasms.

(*2*) Nevertheless, one must not be exclusive, and it is our duty to judiciously utilize against neoplasms all the practical agents contained in the physico-therapeutic armamentarium. Roentgen rays, actinism, sparks and currents of static electricity, radium, ultra-violet rays, ionization, electrolysis, etc., all furnish valuable and often indispensable help in hastening the cure either by destroying the neoplastic particles, or by strengthening the neurons, or by impelling the neoplastic particles destroyed and carried away by the stream of the circulation to take on the necessary elimination, or finally by bringing back the vital processes to the normal.

(*3*) The power of the big bi-polar effluves or of the high frequency sparks is especially more penetrating and more efficacious in the treatment of deep tumors. It is this power that foils with the greatest vigor the whole histogenesis of malignant tumors, and this without the slightest possible suspicion of inflammatory reaction, inasmuch as violet irradiation contains no calorific ray.

(*4*) Malignant tumors from their commencement, recurrent tumors and those considered inoperable, are amenable to physico-therapy.

(*5*) As in *1900* and in *1903*, I still persist in asserting that large tumors should be removed by the bistoury and treated afterwards by my method to prevent recurrence, and to cure a recurrence should it take place.

(*6*) Effluvation and the projection of high frequency sparks should follow all surgical operations on malignant tumors.

(*7*) With the object of preventing recurrence after cicatrization, a few currents applied periodically, then after intervals, whose lengths should be decided by a medical man, seem to me of paramount necessity.

(*8*) Physico-therapy, which is the rational method to employ against malignant tumors, constitute also for them a line of preventive therapeutics.

HIGH-FREQUENCY ELECTRIC CURRENTS IN MEDICINE.

On the subject of the effect of the high-frequency current in medicine, Emil H. Grubbe, of Chicago, says:

The most notable results with this treatment have been obtained in the very common disease,—eczema.

Dr. Bloch, of Paris, one of the most able electrotherapeutists and an associate of the late Apostoli, recently reported a large number of cases of acute and chronic eczema, in all of which remarkable results have been obtained by high-frequency currents, after all other methods of treatment had failed to bring relief. Similar reports came from other eminent observers. Many cases of eczema of ten years standing have been cured with half a dozen treatments. The currents are applied locally and occasion no discomfort whatever. Most sensitive parts may be treated without aggravation.

Acne in all its forms yields readily to this treatment. Psoriasis also is amenable to this treatment. In one case treated, the disease has not returned after ten months.

Malignant growths, particularly epitheliomas, react favorably in the majority of primary cases. Of course, it would be folly to expect a good result from this or any other form of treatment after general carcinosis has set in.

Indolent and fissured ulcers respond rapidly to this treatment and clinical tests reveal results which must be considered permanent.

Since the *x*-ray and the ultra-violet ray have done so well in the treatment of lupus, we would hardly expect to find any other agent to supplant them in fighting this disease. However, there are many cases which do not do well under either of the above forms of treatment and many of these have been cured by high-frequency currents.

Probably the results are obtained more rapidly, due to the fact that every time we apply these currents a general electrification occurs, *i.e.*, the whole system is influenced at each sitting. By many operators this treatment is preferred to the *x*-ray, because, as a rule, the results are obtained more rapidly; there is better control of the inflammatory reaction, and the scars are most perfect.

High-frequency currents have also proved of great value in the treatment of catarrhal conditions of mucous membranes and for neuralgias. Even for sciatica, tic douloureux, choreaic and hysterical spasms they offer a very effectual method of relief.

Among the many general diseases which have been favorably affected may be mentioned neurasthenia, rheumatism, gout, tuberculosis and obesity.

In diabetes many observers have obtained such good results that the claim has been made that we now actually have a remedy which can cope with this disease. The decided results obtained in treating anemia and chlorosis by high-frequency currents have been reported by quite a number of observers.

THE THERAPEUTIC EFFECTS OF THE SINUSOIDAL CURRENT.

The reversal of the sinusoidal wave is so rapid that the current is practically continuous. Slow alternations of the current produce greater ionization than when they are rapid.

Is the Sinusoidal Current Electrolytic?—Up to *1907*, all the authors and electricians consulted, excepting Dr. Burdick, maintained that it is not. Their theoretical reason for this contention, I assume to be that the chemical elements which are freed by the decomposition of a substance during the flow of the current in one direction, are reunited by the flow of the current in the opposite direction. If we grant that the above process does take place, the decompositions and recombinations cannot take place instantaneously; for we would not then see in an electrolytic solution any evidence of electrolysis by the sinusoidal current.

In *1902*, while using the current in diseases of the eye, I made some simple experiments, which satisfied me that the current is electrolytic. If the electrodes of an Alternator be placed in a solution of potassium iodide, the solution is promptly stained brown and gas bubbles appear as rapidly as when a direct current is used. If two copper terminals of a high voltage Alternator be brought in contact with a piece of meat, disintegrated copper will be disseminated through the meat from pole to pole; while, with the galvanic current a copper chloride appears only near the anode.

This latter experiment seems to demonstrate a greater *polar* action with the direct current and a greater *inter-polar* action with the sinusoidal, which is the more important current for the treatment of the body or body organs as a whole.

In *1907*, Guilleminot, who has written one of the best books on the physics and therapeutic application of electricity, stated: Experiments, both physical and physiological, by various scientists, have demonstrated the electrolytic action of the sinusoidal current. Guilleminot believes the ionic changes in the tissues, produced by the sinusoidal current, are comparable with those of the galvanic. I believe, on account of the greater clinical results obtained by the sinusoidal current, as compared with the direct, in the same patient, that the ionization is greater in the sinusoidal: if we may assume the results are due to ionization.

THE EFFECT OF THE SINUSOIDAL CURRENT UPON THE NERVES OF SPECIAL SENSE.

The response of a nerve to stimulation is manifested by the character of its function. The stimulation of a motor nerve is manifested by muscular contraction. The stimulation of the optic tract is shown by the resulting light sensation—or phosphenes. The sinusoidal current, compared with others, appears to have a specially stimulating effect upon the nerves of special sense. It may be that a greater nerve vibration is produced by the rapid alternation of the electric energy.

I have not been able to produce light flashes with my faradic, high-frequency or static current, or with the *x*-ray or mechanical vibrator. The galvanic current produces, when constant, but especially when interrupted, a moderate intermittent flash, with a painful sensation. This does not compare with the constant, brilliant, variegated mosaic, painless flash produced by the sinusoidal, with the same voltage. I also believe that the alternating current stimulates more the vaso-motor circulation and, therefore, the nutrition of nerve tracts. For the above reasons, as well as for its electrolytic effect, I have used no other current, since *1901*, in cases of primary or secondary atrophy of the optic nerve. In a pretty extensive search of the literature of the last quarter of a century, I do not find any reference to the use of the sinusoidal current in the treatment of diseases of the eye or ear. I hope that, at no distant day, this invaluable agent will meet with proper recognition.

The stimulation of the nerve centres is due to ready conduction of the current, by the nerve fibres, to the nutritive vessels of the neurolemma and to the trophic centre,—the cell body, (neuron). Thus nerve nutrition is promoted by increased vascularity and direct cell stimulation. The functional specialization of a nerve fibre depends only upon its connection with a nerve centre. Whereas the stimulation of vibratory massage is limited to the nerve terminals, or, at most, to the nerve fibres, an electrical current stimulates the nerve centres also.

In the application of the sinusoidal current to the eyes, I use the same electrodes as when treating with the direct current. The voltage tolerated by the patient at the initial treatment is a fair guide to the amount required for subsequent treatment.

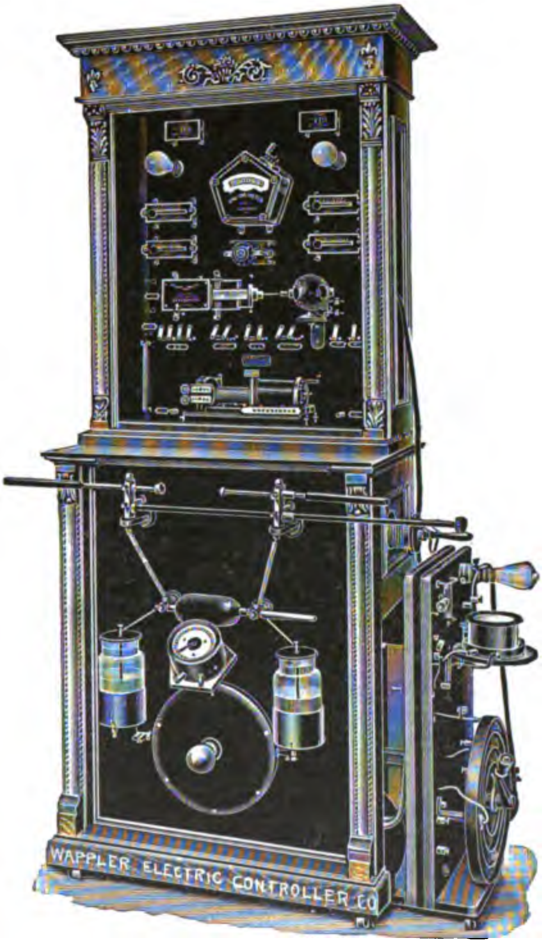


Fig. 78.—X-Ray, Galvanic, Faradic and Sinusoidal Combination Machine.

THE RELATION OF MAGNETISM TO THERAPEUTICS.

The concensus of opinion is that magnetism has no perceptible effect upon the organism. I extract the following from Scheppegrell:—"The effects of magnetism in therapeutics have been investigated by Peterson and Kennelly, who have, recently, tried it with an exceedingly strong field, and have come to the conclusion that "the human organism is in no way, appreciably, affected by the most powerful magnets known to science." A. E. Dolbear, of Boston, however, holds that it is not proved that magnetism is without any effect on the human body, but believes that the experiments, which have been made, simply show that magnetism, unlike electricity, does not produce the mechanical and chemical changes necessary to be appreciated by the subject."

Personally, I cannot believe that it will not yet be demonstrated that magnetism has very appreciable, vital and beneficial effects upon the human body. Two effects are inseparable from every manifestation of electricity,—heat and magnetism. The effect of the heat product, in the application of electricity to the body, is *palpably* manifest. If magnetic lines can induce the secondary currents which we use in the faradic wall plate, in the high-frequency and sinusoidal apparatus, it would seem only reasonable that the human body in conducting a current, should be affected by the *magnetic lines* given off by the current within the tissues. Many effects of the current upon the tissues are known, and it may yet be shown that magnetic lines have a large share in producing those effects.

CHAPTER II.

PHOTOTHERAPY.

THE PHYSICAL AND THERAPEUTIC PROPERTIES OF ELECTRIC LIGHT.

Physical Properties.—The rate of vibration of the rays of the light spectrum is interpreted by the eye in terms of color. Vibrations at the rate of *481* billions per second are perceived as red; and, at *764* billions per second, violet.

Beyond the visible violet of the spectrum, are rays called *ultra-violet*, and, below the red, *infra-red.*

The spectrum is further divided into three parts, which have chiefly chemical, luminous, and heating properties. Experiments have shown that the greatest intensity of the light rays is in the yellow part; of the actinic or chemical rays is in the violet and ultra-violet region; and, of the heat rays is in the red and infra-red part. To a less extent, the chemical, luminous and heat rays produce their characteristic effects in the whole spectrum.

Light energies, especially the violet and ultra-violet, are bactericidal to organisms on the surface of the body,—the effect is due to the oxidizing action of free oxygen.

Light is not directly bactericidal to organisms within the body, but, by the improvement in the cellular condition, it promotes physiological resistance to the growth and increase of bacteria.

The ultra-violet rays are the greatest in bactericidal power, but the blue, violet and longer wave lengths are capable of greater penetration of the tissues.

"The complex of white and ultra-violet rays has the most therapeutic value." (Cleaves).

Tyndall found that in a gas flame the value of the luminous radiation is *4* per cent, and, of the obscure or heat rays is *96* per cent. In electric light, the value of light rays is *10* per cent and of the heat rays *90* per cent.

Chemical Properties.—The general supposition of the physician is that the therapeutic effects of the electric lamp are alone due to heat radiation,—and that the light radiations produce a very negligable effect. A consideration of the properties of light should dispel any doubt in regard to its effect upon the body tissues.

Scheele found that when silver chloride is placed in the violet rays that the salt blackens more than when put in any other part of the visible spectrum. Wolloston found that the action extends beyond the violet, and these rays are sometimes called the actinic or chemical rays *par excellence.*

The experiments of Bordier show that blue tints *1*, *2*, *4*, *6*, and smoked glasses *2* and *4* have an actinic transparency as great as colorless glass. The yellow glass (Motais) tints *2*, and *3*,—especially *2*,—have a great transparency for actinic rays. Very dark yellow (No. *4*,) arrests nearly all the actinic rays. Green glass (Fienzal, No. *2*,) allows some actinic rays to pass, whereas, *4*, and *5*, arrest all the rays. The ultra-violet rays cannot pass No. *4*, and *5*, green glass.

The chemical action of light upon the growth of plants is well known. Benson and Roscoe have shown that whenever chemical action is induced by light, an absorption of light takes place.

THE PENETRATION OF LIGHT.

Gebhard, after passing red rays through the wrist, produced a photograph on a sensitized plate.

G. E. Rogers, Chicago, says: "I discovered that when the brilliant spots of a *500* candle-power incandescent lamp are projected upon the human body, they not only penetrate, but pass entirely through the tissues including the bones."

ULTRA-VIOLET RAYS.

The committee on Photo-Therapy af the American Electro-Therapeutic Association, for *1912*, presents the following observations on the subject of Ultra-Violet Rays:—

Bordier has studied the penetrating power of these rays in relation to all manner of substances and solutions, including the fluids and tissues of the human organism.

In regard to the tissues of the eye, he finds that the vitreous humor is as transparent as water, but the cornea arrests a large proportion of the rays, thus protecting the deeper parts of the eye. The crystalline lens is completely opaque to these rays, but becomes fluorescent under their influence, and fulfils the duty of protecting the retina in this way. The author suggests that it may itself suffer from their action, resulting in the early production of a cataract, as in the case of glass makers and founders. Eyes operated upon for a cataract, and in consequence, deprived of their natural powers of defence, should be especially protected against the action of the ultra-violet rays.

Bordier points out further that such lights as the arc lamp, the Auer light and the mercury vapor light should be used only for the illumination of large spaces. On the other hand, the work-table or desk should be lighted by the oil lamp or electric bulb, which are very feeble in ultra-violet rays.

The author makes the further interesting observation that the dust and smoke in the atmosphere of towns occlude these rays; hence sunstroke is much rarer in cities than in the country or in the mountains. On the other hand, he suggests that the tonic effects of the country air are due to these rays.

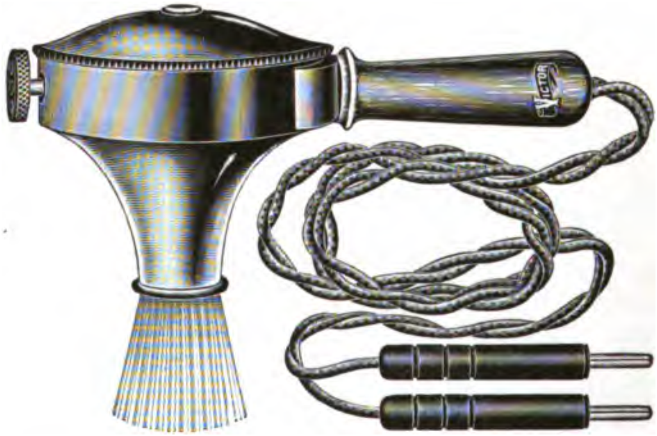


Fig. 79.—Ultra-Violet Lamp.

THERAPEUTIC LAMPS.

Those in general use are the *50*, *500* and *800* candle power incandescent lamps, the arc lamp and the Finsen lamp.

The incandescent lamp is very convenient, as the intensity of the rays remains very constant, and the intermissions of its application can be left to the patient, who intercepts the rays with a fan as often as it is necessary.

The lamp has the disadvantage that the glass globe intercepts the ultra-violet rays, which have the greatest chemical or bactericidal effect.

Rogers writes: "After experimenting, I produced, in /99 a structure, by which the light from high candle power incandescent lamps was projected within a predetermined area, non-parallel beams crossing each other in sufficient numbers to form one or more brilliant spots. These are the penetrating points to which I refer as the new force, new rays, or rho rays. These spots can penetrate the tissues, including the bones, as can be proved by photography."

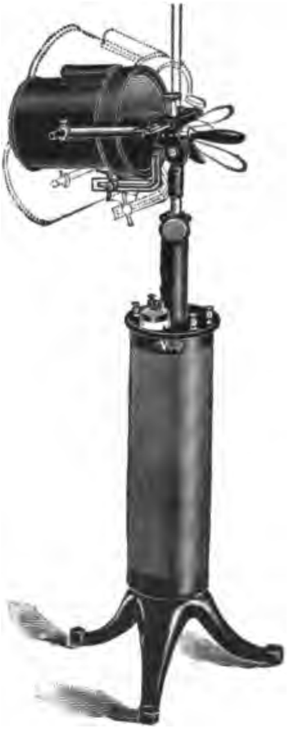


Fig. 80.—Therapeutic Arc Lamp

The Arc lamp gives a less steady light and requires constant supervision, but gives a light of great intensity and bactericidal power.

The Finsen light gives violet and ultra-violet rays, produced by an arc lamp; the heat rays being

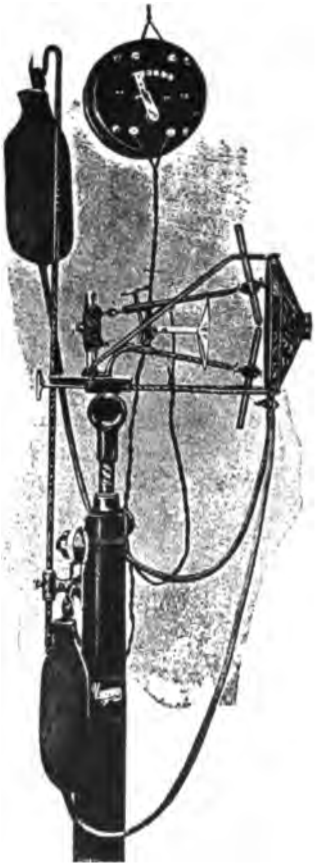


Fig. 81.—The Finsen Lamp for Treatment of Skin Diseases.

intercepted by rock crystal lenses. The lamp consumes *40* to *80* amperes of current and *45* to *50* volts.

The *incandescent* and *open arc* lamps may be lighted by the direct or alternating current. They may be operated by the *110* or *220* volt supply.

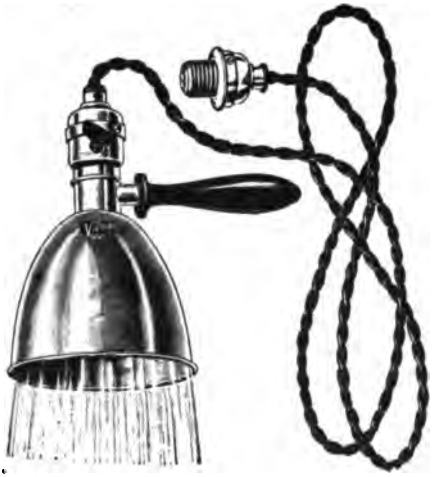


Fig. 82.—76 c. p. Therapeutic Lamp.

Fig. 83.—Color Screen.

The light which Dr. F. Howard Humphris, of Edinburg, uses, consists of a *500* candle power incandescent electric globe with a carbon filament, which carries about twelve amperes of current. He emphasizes the point that the lamp must be a single carbon filament, capable of carrying twelve amperes, and not several smaller lamps, which, in the aggregate, give the same candle power. A cluster of small lights, though it amounts to *500* candle power and even more, will not produce the effects of the single filament carrying the larger amperage.

THE THERAPEUTIC USE OF THE ELECTRIC LAMP.

The analagous physical phenomena and chemical effects produced by *light* and *x*-rays, strongly indicate that the therapeutic effects of the *lamp* are similar to those of the *x*-ray tube. In fact, this theoretical indication is so strongly corroborated by clinical experience that phototherapy and radiotherapy are applied in the same class of cases.

My own experience has been longer with the *x*-ray, and, thereby, established a preference in its favor; but this has been more and more displaced by a trial of light. Also, in many instances, physicians, who have used the lamp and the focus tube, coincidently, for a considerable time, in epithelioma and the various skin diseases, etc., have almost completely abandoned the *x*-ray in favor of *electric light.*

There are on record numerous cases of epithelioma, etc., which have recovered under the use of the lamp, after the use of the *x*-ray had proven itself to be ineffectual. The reverse of this has not come under my observation.

An inestimable advantage in the use of light is that its technique can be easily acquired; that it, then, almost never produces untoward effects; that even these effects are immediate and readily yield to treatment. The technique of the application of the *x*-ray on the other hand, is mastered only under considerable teaching, or by a long personal experience—during which, the patient is liable to actual or potential casualties,—and, in the end, the most experienced operators often meet their Waterloo. Also an untoward result may unavoidably occur on account of the idiosyncrasy of the patient.

It may be thought that the *x*-ray energies have greater penetration than those of light. Neither the physical characteristics nor the therapeutic effects of the *x*-ray will substantiate the supposition. X-ray vibrations are shorter than the shortest vibrations of light,—and, it has been determined that the longer vibrations of light have more penetration than the shorter,—hence, logically, than those of the *x*-ray.

I have not observed more favorable results reported by the use of *x*-rays than by the use of light in the treatment of deep seated diseases; whereas, The Committee on Photo-Therapy, of the American Electro-Therapeutic Association, for *1911*, submitted a report to the effect that no physical agent produces so extensive oxygenation of the blood as does light.

Julius Rosenburg, of New York, writing of Photo-therapy, says—Experience has taught me that to obtain results an exposure must last from fifty-five to seventy-five minutes; a shorter application is not of lasting benefit.

I now use the ultra-violet rays of a fifty-five ampere iron carbon arc. Mirrors enable me to throw and concentrate the light upon a given point.

Many cases of the recovery of neuritis by this agency are cited; one of facial neuritis of one year's standing. The teeth were drawn with no improvement resulting. After seven applications of the ultra-violet rays, the patient was free from pain.

THE THERAPEUTICS OF LIGHT.

Herbert McIntosh, of Boston, offers the following *summary* on the action of light:

a. The light penetrates the tissues.

b. That, in so doing, the chemical rays produce fluorescence of the blood and serum, which is reduced or absent in pathological states.

c. That the action of light upon the blood stream reduces oxyhemoglobin and thus stimulates the chemistry of the tissues,—that is to say, improves metabolism.

d. That the most useful portion of the spectrum is not the heat or luminous portion, but the chemical.

e. That the physiological effects of light flow easily from the marked penetration of the light rays, particularly the chemical portion of the spectrum.

f. That the blue light has a peculiar field in the control which it has over pain and hyperemia.

g. That red light, by its exclusion of the chemical rays, plays an important role in the treatment of smallpox.

The use of light is a most important addition to the physician's equipment. A substitute for the arc lamp is the high power Incandescent lamp. Here, however, the ultra-violet rays are entirely cut off by the enclosing bulbs and the treatment is largely a radiant heat treatment. This is, of course, of great value, but, manifestly, inferior to a treatment which utilizes the whole spectrum, as does the arc light.

Writing of Light and its therapeutic effects, William Benham Snow, of New York, says:—Maxwell first proclaimed the vibration theory of light, demonstrating that "the differences in color were due to differences in wave-lengths or oscillation and frequency, and that the color-sense corresponding with the varying gradations of the spectrum was due to the rods and cones in the retina, thereby exciting in the brain through the optic nerve the sense of color-sensation."

He also states: "The chemical region of the spectrum, then, is that of the ultra-violet, with some of the violet for ordinary silver salts; but there are preparations which respond to the yellow and the red somewhat."

The rays of greatest refrangibility—the violet, blue, indigo, and higher invisible ultra-violet rays—designated the chemical rays, of the greatest frequency, are the least penetrating. These chemical rays, while possessed of the greatest destructive qualities to germs, when brought in close relation to them, are capable only of affecting the most superficial conditions. They are capable, however, of destroying superficial germ processes; but only when the tissues are rendered anemic, according to the method of Niels Finsen as employed in the treatment of the two types of lupus.

They are also capable of setting up most active superficial hyperemia and dermatitis. Deficient in penetrating power, they fall short, in the treatment of the deeper-seated conditions, of the effects produced by the less refrangible rays, particularly the yellow and orange.

In considering the therapeutic uses of light, it is not our purpose to consider light according to the divided rays of the spectrum, but collectively and in conjunction with heat radiation·

When considered from this point of view, we have in the combined radiations a potent means, including all the effects derived from the usual sources of light: (*1*) The rays of the sun, or solar light; (*2*) the electric arc; and (*3*) the incandescent light.

Solar light, as employed in solaria, may be condensed by the use of lenses both for the purpose of separating the higher frequencies and in collected parallel rays for the purpose of deriving effects of greater intensity than from normal sunlight. The intervention of cloudy days and other atmospheric conditions are so variable, that they are unreliable. Compared with the electric arc and the incandescent light, the sun's rays contain a larger percentage of the chemical rays than the rays from the incandescent light, and a smaller percentage than the rays from the electric arc. The distance at which the patient is placed from the electric arc diminishes the percentage of chemical rays with every foot, they being filtered out or absorbed, as are the sun's rays by their passage through the atmosphere.

The chemical rays are also absorbed, or their efficiency destroyed, by their passage through glass which accounts for the lower percentage of these rays from the incandescent light. (This does not apply to the blue-violet of the visible spectrum;)

The employment of rock crystal lenses, through which ultra-violet rays pass readily when derived from the sun or the electric arc, according to the method of Finsen, permits concentration and passage with the least loss for therapeutic administration to conditions where germs, such as lupus and the tubercular, are to be destroyed.

The rays of highest refrangibility induce an intense degree of superficial hyperemia; but that it is also produced with a necessary degree of efficiency from the rays of lower refrangibility, with less risk to the delicate structure of the skin, seems to have been demonstrated.

We are therefore placed in the position that, in the election of the apparatus, it is more desirable, except when employed in the treatment of lupus and similar conditions (in which, however, the Roentgen ray has proved more efficient,) to employ the combined rays of the spectrum as projected in parallel, than to separate them into the various frequencies of the spectrum.

The idea is rapidly becoming pregnant in the professional mind, that in the methods of phototherapy the indications are generally for the employment of white light.

Light as a Remedial Agent.—J. W. Kine, of Fort Dodge, Iowa, writes that in photographing through the body, the direct rays of the sun falling through the skylight upon the reflector are focussed upon the chest of the person, upon whose back has been placed the photographic plate and upon it a picture is taken.

By means of the Kine phototherapy reflector, a light is produced which has twenty times greater intensity than that of sunlight. As the actinic rays are desired rather than the heat rays, blue glass is placed in front of the reflector.

1. The chemical rays of light are powerfully germicidal. *2.* The chemical rays are irritant to all the tissues through which they pass.

In using light in cases of lupus nasi, Kine employs the following technic: A circular mirror thirty inches in diameter and overlaid with blue glass is used. All the light falling upon it is focussed upon a spot six inches in diameter and at eight feet in front of it.

A case of lupus nasi came under his care August *9/98.* He gave light treatment daily for half an hour for three weeks. The ulcer was completely healed and there was no recurrence.

He says that the ordinary cases of lupus usually require treatment for from four to twenty weeks.

THE EFFECT OF LIGHT ON BACTERIA.

As far back as *1876*, says Dr. Jay Frank Schamberg, the destructive effect of light on bacteria was proved by two English workers, Downes and Blunt, in an investigation most remarkable for its accuracy of detail.

Dieudonné observed that bacteria were killed in half an hour by direct sunlight, in six hours by diffused daylight, in eight hours by electric arc light of *900* candle power, and in eleven hours by the electric incandescent light.

Von Jansen demonstrated that a piece of skin inserted between the light source and the bacteria did not prevent their death when the thickness of the skin was *1.2* m. m. and the exposure one and one-fourth hours.

Busck killed with light pneumoccocci inoculated into the cornea of rabbits.

On the other hand, Klingmüller and Halberstadter claim that the Finsen light does not kill the tubercle bacilli deep in the tissues. They exposed pieces of lupus tissue for ten minutes to the Finsen lamp and then inoculated them into the peritoneal cavity of guinea-pigs. That the bacilli were alive was evidenced by the fact that tuberculosis resulted.

More recent studies by Bie have established the important fact that the blue-violet end of the spectrum does not exclusively possess bactericidal properties. He says: "I found that with the application of a sufficiently strong light all portions of the spectrum were able to restrain the growth of bacteria or to kill them. The red rays possess the weakest power; this power then increases as one approaches the ultra-violet end of the spectrum, where it is strongest." Four per cent. of the bactericidal effect was ascribed to the red, yellow, and green rays; while the blue violet, and ultra-violet rays exercised about *96* per cent. of the effect. Red, orange, yellow, and green act only after long exposures. Pure red requires one and one-half hours to produce a determinable effect on bacteria.

Bie admitted that hydrogen peroxide is formed in many nutrient media on exposure to light, but claimed that bacterial death is more rapid in media in which no hydrogen peroxide can possibly form.

Downes and Blunt early suggested that the destruction of bacteria by illumination depends on an oxidation process and requires the presence of free oxygen. Bie's experiments led him to the conclusion that the destruction of the bacteria is not an oxidation process in the sense that the presence of oxygen is a necessary condition. The stronger the light in the blue, indigo, violet and ultra-violet rays, the less does its bactericidal effect depend on the presence of oxygen, and vice versa; the fewer the chemical rays that the light contains, the less able is it to kill bacteria without the aid of oxygen.

The researches of Hertel are most interesting in this connection. Hertel claims that the short-waved rays of light (chemical rays) cause a splitting off of oxygen from the blood and cell plasma, much in the same way as oxygen is freed from plants by light, and that this process affects both the tissues and the bacteria.

A. B. Dorman, of Winthrop, Mass, writes, under the title, "Results Obtained From the Use of the Blue Light:" "Light as a therapeutic agent is of undoubted value, and I have got from its use fewer disappointments than from the employment of any of the other modern drugless methods. The object of this paper is simply to give you the results obtained by me, from the use of the *blue light,* in the treatment of certain cases.

First, I will say that I have very little to do with the *x*-rays. I have made some use of the sun's rays, the *50*-candle power Minim lamp, a *150*-candle-power lamp with parabolic reflector, and the arc lamp. The two which I have made the most use of are the arc and Minim light.

The arc lamp which I have made use of has a deep parabolic reflector, and a rheostat permitting a flow of from *3* to *10* amperes, the variation being approximately from *300* to *3,000* candle power.

The Minim lamp is inexpensive and portable. There are three or four sizes of bulbs which come with this lamp, but I have always made use of the *50* candle power, and not the smaller ones. Some say that all the effects produced by this lamp are due to heat only, but in this I do not agree, for in making use of the Minim lamp it is only necessary for the patient to experience a feeble sensation of heat· I believe that it is the color, largely, which brings about the beneficial results. The bulb should be made of blue glass, and the only ones which I have used with any success are those which are called the Minim bulb. I am certain that you get in these particular bulbs a larger percentage of blue light, and I have no doubt that they are made different, in degree of color, from the ordinary blue glass bulbs which can be purchased in most of the supply stores. The manufacturers call it the "ultra-violet ray" apparatus, but of course this is not correct and is misleading to anyone who does not know about the nature of the ultra-violet rays, for you get no ultra-violet rays, from this lamp.

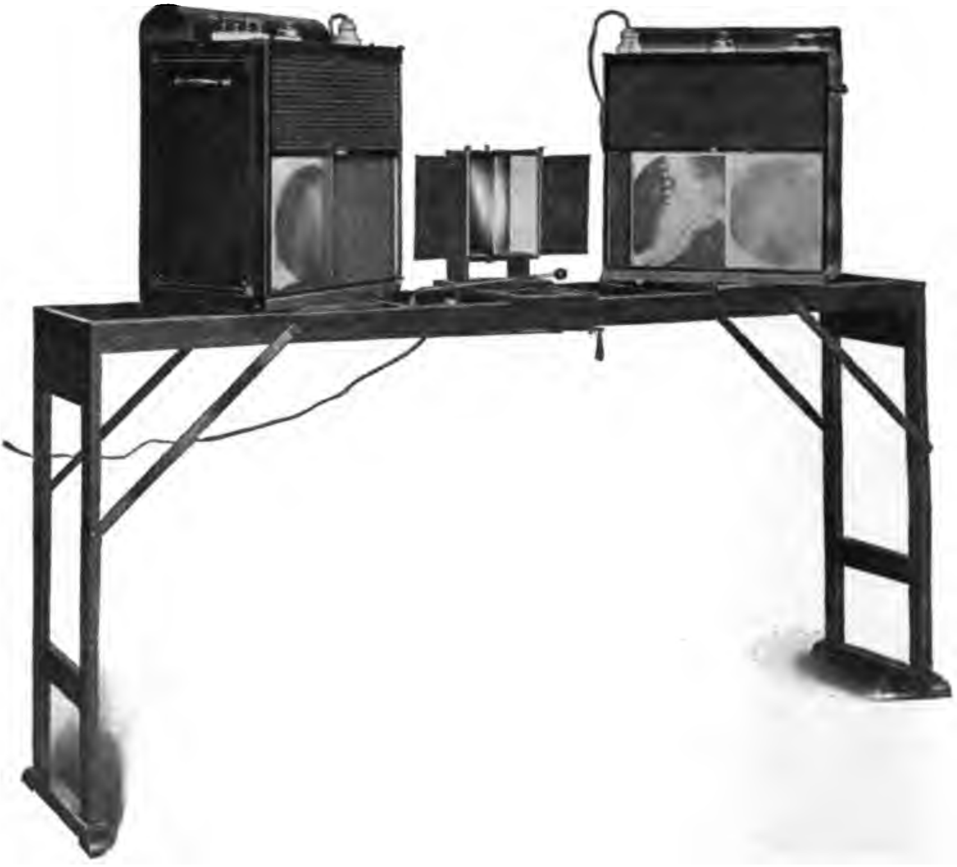
I will state only two cases, giving results, the lamp I used in each case and the technic, which is very simple.

A Case of Recurrent Rheumatic Iritis.—Mr. T., age *35*. Having suffered from recurrent rheumatic iritis for six years, each attack coming on about every twelve months and lasting from six to fourteen weeks, was induced to come to me for treatment. On November *11*, *1905*, he came to my office suffering severe pain and having had little relief from pain and loss of sleep for a number of weeks. He said nothing could be done for him during these attacks, that amounted to anything, and when the pain got too severe and he felt that he must sleep, he took something in the form of an opiate. He said that each attack seemed to have run its course and got better when it got ready. This patient said he had consulted several physicians, as well as eye specialists, with little benefit. I at once decided to use the blue light. I had the patient take the recumbent position, with the eyes closed. I placed the light, which, by the way, was the Minim light, *14* inches away, and in about *12* to *15* minutes pain was all gone, and he has never had an attack since, being three years ago. I followed the first treatment with five or six others, one a day, which was all that was necessary, but strange as it may seem, his suffering was at an end after the first *15* minutes treatment.

Mrs. H. was afflicted with what is commonly known as shingles. She was admitted September *7*th, *1905*, and I commenced the use of the blue light, and in one week's time she was discharged, cured. At this time the Minim lamp was used. She was suffering much pain when she came under the blue light treatment, and had been for some days previously, and I think that in a poorly nourished anemic person, as in this case, it is fair to presume that the treatment aborted the course of the disease, and did give relief from the first treatment.

In an article on Simple Methods of Relieving Pain, J. H. Kellogg, writes thus of Radiant Heat:—"Radiant Heat consists of the application of a lighted electric lamp, with a suitable reflector, to the part affected. It is a most excellent heat to relieve pain. The heat is more penetrating than that from any other source except the arc light and sunlight."

J. R. Dixon, of Toronto, says:—"I have employed the incandescent lamp a great deal after *x*-ray work. When you are compelled to *x*-ray a part for a long time and the parts get in such a condition that there is a fear of their breaking down, the light will improve the local nutrition of the skin."



Stereoscope for Viewing X-Ray Pictures.

CHAPTER III.

THE X-RAY.

The *x*-ray is a stimulant, which, in moderation, causes hyperemia; and, in excess, produces necrosis. The greatest effect of the radiation is at the terminus of the penetration of the ray. The body cells are supposed to absorb the rays and fluoresce, then chemical reaction follows. Radiation increases cell growth, leucocytosis and phagocytosis. It causes the degeneration and absorbtion of such low resisting tissues as epithelioma, sarcoma etc., while the higher resistance of normal tissue protects it from untoward effects.

C. E. Ochsner and others observe that exposures to *x*-ray at first greatly increase the vascularity of the tissues, while, under extended treatment, these become ischemic, brittle, and bleed much more freely than does normal tissue.

THE TECHNIC OF THE APPLICATION OF THE X-RAY.

The factors which enter into the amount of dosage are:—

1. The vacuum of the tube.
2. The degree of fluorescence of the tube.
3. The distance of the patient from the tube.
4. The duration and frequency of the treatment.
5. The depth of the tissue to be treated.
6. The effects produced by the treatment.

1. The most practical and convenient way to measure the dosage—or, intensity of the tube—is to measure the distance through which it forces a spark between the prime conductors of the machine. The higher the vacuum of a tube the greater is its resistance. Hence, the stronger is the current needed to overcome the resistance and the greater is the energy of the tube.

A tube is *low* when it forces a spark from one to three inches only between the prime conductors of the machine; *medium* when a spark is forced from three to five inches; and *high* when the distance is above five inches.

2. Grubbe, alone, seems to regard this factor. He recommends a *barely discernible* light in the tube. When a brilliant light is reached, it will not be intensified by a large increase of the voltage; hence, the constancy of the dosage can be best secured with a faint light.

3. It is a good working rule to place the patient from one to two inches further from the surface of the tube than the greatest distance which the tube can force a spark across the spark gap.

4. Three to ten minutes with the coil, or five to twelve with the static machine—when the raying is constant. With interrupted flashing, (Cook's method), I am in the habit of giving from five to twelve minutes treatment, during which, the tube is active only half the time. The frequency of the treatment should lessen progressively at first, daily, for one or two weeks; then, tri-weekly, etc.—as the effect is cumulative.

5. The greater the depth of the tissue to be treated, the higher must be the vacuum of the tube,—and this is indicated by the length of the spark gap. The gap may be two inches for the treatment of the lids and surface of the globe, and from three to five for intraocular and orbital treatment. The vacuum of the tube can be maintained only by placing the wire automatic regulator just beyond its sparking distance from the cathode of the tube. In use, the vacuum tends to rise, on account of the dissipation of the contents of the tube either in or through its wall, or upon the surface of the electrodes. When the rise of vacuum increases so high, as to prevent the current passing through the main tube, it passes through the auxiliary tube to the tip of the regulator. This regulating discharge passes through a bunch of mica discs in the accessory tube,—heats them and liberates occluded gas which flows through the main tube, lowers its vacuum and, again the current passes through it.

The vacuum can also be lowered, as desired, by connecting the cathode cord with the regulating wire and the anode cord with the anode of the tube. The vacuum is raised by connecting the anode cord with the platinum coil which is in the auxiliary chamber and which is heated, and absorbs the air in the tube.

A good focus tube should concentrate the cathode rays upon the centre of the target producing a dull spot when in action and it should be possible to raise its vacuum in five to ten minutes, and lower it in a few seconds. It should be made of glass that is free from lead. The presence of lead interferes with the transmission of the *x*-rays and hence, in order to interfere the least with the transmision, it is necessary to make the tube thinner and more fragile than is desirable.

6. If itching, burning, redness, swelling, pigmentation, blanching or loosening of the hairs appears, discontinue the raying until these symptoms disappear, unless dermititis is desired.

Notwithstanding the many applications for the regulation of *x*-ray dosage, most operators depend upon the length of the spark gap of the exciting machine.

As the *x*-ray has, perhaps, been used more extensively in diseases of the skin, than in any other class of diseases, and as Dr. William Allen Pusey, of Chicago, has had one of the longest and most extensive experiences in its use, and has embodied his views in one of the best written books on the subject, I gladly avail myself of the opportunity of bringing to my readers the results of his wide experience, by quoting freely from his work, entitled:—

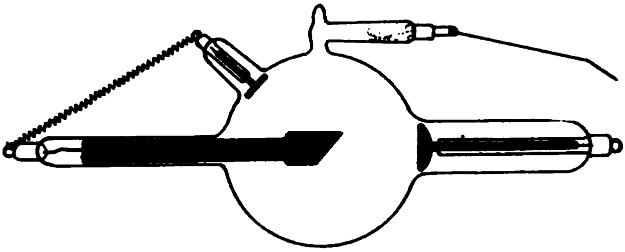


Fig. 84.—X-Ray Tube With Automatic Regulator.

"ROENTGEN RAYS IN THERAPEUTICS AND DIAGNOSIS."

The Effect of X-Rays on Tissues.—The first effect of *x*-rays upon the skin is either slight pigmentation, slight erythema, blanching or loosening of the hairs. Either one of these changes may come first. Pigmentation may occur without redness; again, it may be very slight, or not occur, or be completely overshadowed by the redness· Loosening of the hairs frequently occurs without blanching, but I have not seen the reverse happen. Neither of these latter changes occurs without accompanying pigmentation or erythema.

Pigmentation.—This pigmentation from moderate *x*-ray influence differs in no apparent respect from that produced by exposures to sunlight. Skins which burn rather than tan under sunlight develop erythema rather than pigmentation under x-rays.

Dermatitis.—The inflammatory effects produced by x-rays upon tissues may be divided into four classes. In burns of the first degree, there is dry dermatitis with erythema without destruction of tissue; in burns of the second degree, dermatitis with the formation of vesicles and blebs, but without deeper involvement; in burns of the third degree, destruction of the epidermis; in burns of the fourth degree, the destruction involves not only the entire epidermis, but the corium as well, and also the underlying tissue to a greater or less extent.

Deep Seated X-Ray Effects.—Several cases have been reported of internal lesion due to x-rays without corresponding effect upon the overlying tissue. It is, I believe, *a priori* highly improbable that primary deep seated x-ray effects can be produced upon normal tissue without more intense effect being produced in the overlying tissue, and there are no cases on record that tend to weaken this theoretical position.

Time of First Appearance of Symptoms.—The time varies from the appearance of symptoms at the time of exposure or a few hours later to several weeks thereafter. In a vast majority of cases, however, the first appearance is from three to fifteen days after exposure. In Codman's table, of 70 cases, the signs and symptoms in three instances occurred after the fourth week.

Cumulative Effects.—Since there is a period of incubation, lasting several days, and since the effects themselves continue for many days, it follows necessarily that exposures repeated during either of these periods must increase the effect upon the tissues.

Idiosyncrasies.—According to almost universal opinion, there is a marked difference in the way in which tissues of different individuals react to the influence of *x*-rays.

Question of Dangerous and Safe Exposures.—In Codman's table, of *45* cases, which have caused injury, there is one case in which an exposure *19.68* inches from the tube for *30* minutes caused injury after one day of incubation.

I believe, says Dr. Pusey, that a moderate variation in the susceptibility of individuals is constantly found, but that this difference rarely amounts to more than four times as great susceptibility in one individual as in another. The only part in which I have found particular susceptibility to *x*-rays is the eyes. Cases of conjunctivitis from *x*-rays have been reported by King and Scherer. Conjunctivitis is readily produced by *x*-rays, and the process by involving the cornea, may become dangerous to sight. In *1902*, I called attention to the possibility of atrophy of the rods and cones of the retina from *x*-ray exposures. Apparently, that danger was theoretical rather than practical, for the effect upon the conjunctiva and cornea will in all probability become severe before the effect will show in the retina. Scholtz believes that the only effect produced upon the eyes by *x*-rays is conjunctivitis and that there is no effect upon the retina.

With regard to the above, in my experience, I (Coleman) would say, that I have found the eye tolerates the *x*-ray much better than does the surrounding tissue, neither of which do I ever protect. This toleration is probably due to the constant moisture of the eye. A conjunctival reaction has almost never occurred. In one instance, a punctate keratitis occurred without any conjunctivitis.

Retinitis has not occurred in any case. In two instances, necrosis of the upper lid took place, and, in one other, there was the temporary loss of a lovely pompadour; in a very few, the loosening of some of the lashes without any involvement of the eye. Notwithstanding this, the importance of so invaluable an organ as the eye demands the utmost caution in exposing it to *x*-ray treatments. I would add one simple precaution. Test the vision before each seance, and, if it be found lower than at the previous visit, discontinue temporarily the treatment.

Pusey has never had any reason to believe that skins that are dry and skins that are covered with sweat are of any appreciable importance in determining the production of *x*-ray effects upon the skin.

Anodyne Effect of X-Rays.—Many observers have called attention to the marked anodyne effect of *x*-rays in painful conditions. The anodyne effect of *x*-rays is not confined to malignant diseases. Gocht has reported a very severe case of trigeminal neuralgia, which was entirely relieved by fourteen *x*-ray exposures. Stembo has reported twenty-eight cases of various forms of neuralgia, of which twenty-one or *75* per cent. were promptly relieved. Relief usually followed three exposures.

The Effect of X-rays on Bacteria.—The fact that organisms in living tissues can be destroyed by exposures to *x*-rays, while the same organisms in inert cultures are uninfluenced by *x*-ray exposures, proves positively that it is not the influence of *x*-rays *per se* that causes the destruction, but that the tissues themselves, doubtless under conditions of activity excited by the *x*-rays, play the important role in the germicidal process. It may well be imagined that this process is in the nature of stimulation of the cells, which are rendered thereby better able to take care of the invasion of the organisms. That the effect on bacteria is caused by increased phagocytosis, has been suggested by Blaise and various other writers. The evidence now at hand points rather against very marked effect upon bacteria deeply seated in the tissues.

Influence on Tuberculosis.—Musham concluded that *x*-rays exercise no influence on general tuberculosis, but that they restain local tuberculosis to a point where its action is very slight. On the other hand, Ausset and Bedart have reported tuberculosis peritonitis cured under the *x*-ray exposure.

In tubercular conditions of the eye, I (Coleman), have found *x*-rays most effective for relief.

What is the Property in X-rays That Affects Tissues?—Accepting, as we must that the changes in tissues produced under *x*-ray exposures are due to the *x*-rays themselves, what is the property in *x*-rays that causes these changes? A little consideration leads inevitably to the conclusion that it is the actinic properties of *x*-rays which are identical with, or very analogous to the actinic properties of light. The physical resemblance between *x*-rays and light are very close. X-rays are by no means all of one character, but consist of "a mixture of rays, which are absorbed in different intensities." (Roentgen.) We have one fact in the effect of *x*-rays upon the organs of sight, which is the strongest possible presumptive evidence that *x*-rays are a form of energy of the closest similarity in character to light; and that is that *x*-rays can produce a light sensation upon the retina. Roentgen states "The fact observed by Herr H. G. Brandes, that the *x*-ray can produce a light sensation upon the retina, I have found confirmed. In November, *1895*, I perceived a feeble sensation when I was in an entirely darkened room, whenever discharges were sent through a Hittorf tube. I never saw this phenomenon repeated, because, later, instead of a Hittorf tube, other apparatus was used, not exhausted so much, and not provided with platinum anodes. On account of their state of high exhaustion, Hittorf tubes furnish rays which are only slightly absorbed. With the hard tubes now in general use, the experiment of Brandes may be easily repeated.''

The author, (Coleman), has not been able to perceive any light sensation, when exposed to his *x*-ray tube—but possibly, the vacuum has not been sufficiently high.

It would seem reasonable to conclude, says Pusey, that the property of *x*-rays that causes rearrangement of the molecules of a silver salt, is the same that effects the cellular mechanism of the intracellular structure. It must be accepted, that *x*-rays have less germicidal power than has ultra-violet. Downs and Blunt conclude from their investigation that light is inimical to the growth of bacteria, and, under favorable circumstances, wholly prevents it. This action is nearly confined to the end of the spectrum. If the germicidal properties of light be represented by a curve, the high point occurs at the violet end of the spectrum, sinking rapidly between the blue and the green, there being still some effect produced by the red rays, and this effect of light is in proportion to the amount of free oxygen in the culture medium. Buchner observes that the rays of greatest germicidal properties, at least, as regards the typhoid bacillus, are those around the blue line of the spectrum, which have a stronger germicidal property than the ultra-violet rays. In other words, the germicidal properties of light rays do not correspond entirely to their actinic properties.

The Technique of X-Ray Exposures for Therapeutic Purposes.—The central idea in every method of using the *x*-ray for therapeutic purposes, is to use the agent so as to get a sufficient effect, while reducing to a minimum the risk of producing *x*-ray burns of severe character.

Standard Light.—I use as my standard a light produced in a fairly soft tube by a coil of *12*-inch spark length, with a primary current of twelve volts and one and one-half amperes, interrupted a thousand times per minute. This current through such a coil produces a thin sparkabout 3½ inches in length, and this produces a light that will give clearly the bones of the hand on a barium platino-cyanide screen at a distance not exceeding 20 inches from the tube. It gives a light, which for therapeutic purposes is, under almost all circumstances, well within the limits of safety. The mode of treatment which I pursue is based upon the repeated use of a small quantity of light, rather than the use of more powerful exposures less frequently. This is done, of course, in the interest of safety.

Duration and Distance.—With such a light, I begin with exposures at 15 c. m. (6 inches) from the surface to the wall of the tube and gradually reduce the distance, so that, by the end of two weeks, if there is no evidence of reaction, the tube is placed at a distance of 5 to 8 c. m. At the end of two weeks, I begin to increase the length of exposures, and by the end of two weeks more, I begin to extend the time, if no reaction appears, up to 15 minutes. The maximum exposure which I give, except in the rarest cases, is 15 minutes at 5 c. m. (2 inches) from the wall of the tube.

Frequency of Exposure.—With such a light as I use, exposures are usually given daily for two or three weeks without the production of any marked degree of dermatitis. When it is desired to get the tissues promptly under the influence of *x*-rays, my plan is to give exposures six days in the week.

Preliminary Exposure to Determine Susceptibility.—When I wish to exercise extreme caution, I give three preliminary exposures of 5 minutes each, with the tube at 15 c. m. distance, with a weak standard light, on three successive days, and then wait three weeks to see if any reaction occurs. Such preliminary exposures, I believe, are an excess of caution under most circumstances.

Distance of Tube.—The distance at which I place my tube is from *15* to *5* c. m. from the surface. When it is desired to produce a decided effect, the tube is usually maintained at *5* to *8* c. m. If exposures are to be given daily, with the tube at a distance of *5* c. m., and ten to fifteen minutes duration, one must be careful to keep a weak light. I have made many thousand exposures of the above character, in many instances have produced acute dermatitis intentionally, but I have never in any case had a burn that caused destruction of the connective tissue. As a rule, upon the appearance of any effect upon the skin the treatment is stopped—unless the situation is grave—and I then wait for the reaction to subside, when the treatment is again begun. It is by no means always necessary to carry the exposures to the point of producing dermatitis in a healthy skin in order to destroy pathological tissues. I wish to emphasize the fact, that, in carcinoma and other malignant diseases, it is by no means always necessary to produce an *x*-ray burn, even of the first degree, in order to get rid of the diseased tissue. There is in my opinion, not the slightest vestige of reason for the claim that *x*-rays produced by the static machine are less liable to cause burns than those produced by coils. As bad burns as there are recorded in the literature have been produced with static machines.

Tubes.—The rays of a soft tube are of relatively low penetration, and this penetrating power increases directly with the degree of hardness of the tube. The quantity of *x*-rays also varies with the hardness of the tube. A soft tube will under given conditions of current, produce a larger quantity of *x*-rays than a hard tube. The quality and the quantity of the rays vary considerably with the age of the tube. A new tube, under given conditions of current, will produce a larger quantity of *x*-rays than can be produced in the same tube under the same conditions, after it has been used for a long time, regardless of its vacuum. A tube, moreover, tends to become harder from use, so that for this reason also, to produce a given quantity of light, a larger quantity of energy will be required in the old tube than in the new one. It is a fact of practical interest that old tubes may be improved by giving them rest from use. I am now using the first tube I ever used. It became so high that no rays could be gotten from it, but, after a rest of several months, it was restored to moderate hardness. No satisfacfactory standard of classifying tubes has yet been found. The usual plan of expressing the hardness of tubes is by describing them in equivalent spark-lengths. This, however, expresses only the resistance of the tube, and furnishes no accurate statemen of the light produced by such a tube. The usual, and perhaps the most practical way of describing the light from any tube is by using the shadow cast by the hand as a standard. The difference in the shadows produced by *x*-rays of different degrees of penetration is very well shown diagramatically in the accompanying illustrations taken from Kienbock.

In the treatment of pathological conditions, tubes must be selected with a view to the depth of tissue which it is desired to affect. It is generally accepted that soft tubes produce a greater effect upon the superficial tissues than hard tubes. This is undoubtedly the case for the reason that only those rays which are absorbed by the tissues produce any effect upon them and the rays from a soft tube are absorbed by the superficial tissues, while those from hard tubes pass through the superficial tissues with a minimum absorption. There is, accordingly, a well defined concensus of opinion that in the treatment of superficial conditions, like skin diseases, soft tubes are the most suitable; while, for deep seated conditions hard tubes of greater penetration must be used. No matter how high a tube may be, some of the rays are absorbed by the first tissues they strike.

The above thorough technique of Dr. Pusey applies, chiefly, to his use of *x*-rays in dermatology and malignant diseases. In the treatment of non-malignant diseases of the eye, it is never necessary to produce a dermatitis of the surrounding tissues. (Coleman).

Protectives.—In all methods of using *x*-rays for therapeutic purposes, provisions are made for protecting the surfaces surrounding the part to be treated. There are two ways of doing this: one is to surround the tube with an opaque covering so that the rays have exit only at one point; the other is to protect, by some opaque covering, the surfaces of the body which are within the influences of the rays. The first method is carried out by placing the tube in a box. The second method consists in using shields, with openings cut in them to correspond to to the area which it is desired to expose· Recently, I have used sheets made from an alloy of *95* per cent lead and *5* per cent tin. I have found that lead *1/32* of an inch thick is not too thick to be conveniently handled, and it is, I believe, best for these masks. My practice from the first has been to cover the masks on both sides with ordinary wrapping paper. This furnishes satisfactory insulation, and has the convenience of being easily washed off and replaced.

Masks for Special Parts of the Body.—In making exposures in the mouth and pharynx, I have used a lead mask of sufficient size to cover the face. To this is soldered at right angles a short piece of block-tin pipe, and a hole cut in the pipe. This pipe can be moulded or cut to the shape required.

Lesions Around the Eyes.—The most difficult skin surface to protect is that of the eyes. Lesions at the canthi can easily be treated because of their distance from the cornea, but, in lesions of the upper lid and of the lower lid, it is more difficult to protect the eyes. It is difficult to protect the conjunctiva in exposing the upper lids. In such cases, one has to rely largely upon giving the exposures very cautiously. Fortunately, the commonest lesions, epitheliomata, that we are called upon to treat about the eye, rarely occur primarily upon the upper lid. Lesions on the lower lids I have been able to treat very easily by shaping the masks to correspond with the curve of the eye-ball and carefully cutting slips to correspond to the area on the lid to be exposed. Then the lower lid can be pulled down by taking a strip of adhesive plaster and fastening it below the border of the lid, and having the patient draw it downwards during the exposure. All of the conjunctivitides I have seen under the *x*-ray exposures have yielded to protargol and boric acid solutions.

Indications for the Therapeutic Use of X-rays.—The effects of *x*-rays which offer possibilities of therapeutic applications are as follows:

(*1*) Their effect in causing atrophy of the appendages of the skin.

(*2*) Their destructive action upon organisms in living tissue.

(*3*) Their stimulating action upon the metabolism of tissues.

(*4*) Their power of destroying certain pathological tissues.

(*5*) Their anodyne effect.

THE USE OF SMALLER DOSES OF X-RAYS IN RADIOTHERAPY.

Prof. H. Rieder, of Munich, says:—

The method much advocated some time ago, for such diseases as lupus, psoriasis, etc., was to give the maximal dose that could be borne without injury to the normal tissues. This method is now rightly being abandoned, since we find the rays often exert a beneficent action when used in such small doses that they have very little, if any, reaction on the skin.

In my opinion then, it is the *minimum* and not the maximum dose which is of the most importance in radio-therapy. The adoption of the largest dose, compatible with the preservation of the skin, is only to be recommended when attacking malignant neoplasms.

The treatment has proved successful in persistent neuralgia of the trigeminal nerve, etc.

In ulcerated and warty forms of lupus vulgaris and erythematosis, the repeated three to five minutes radiations, with a medium hard tube, have proved more successful than intense irradiations with a soft tube.

In lupus vulgaris, the treatment by radio-therapy and photo-therapy seems to give the best results when the individual patches are radiated with the arc, and the whole area with *x*-ray, for five minutes, once a fortnight. For lupus, there may often be other better modes of treatment. Very encouraging results have been obtained by the irradiation of trachoma.

In the treatment of struma and Basedow's Disease, one or two irradiations of five minutes seem to be sufficient to produce therapeutic results.

USING THE X-RAY WITHOUT BURNING.

Albert C. Geyser writes:—All methods of dosage are fallacious, because they cannot take into consideration the idiosyncrasy of the patient.

Two and a half years ago, a tube was perfected which I have named the Cornell Tube. When the tube is brought into contact with the patient, only the ionizing effect of the *x*-ray is exerted, and this is all that is needed to furnish the most brilliant therapeutic results.

During the past two and a half years, this system has been used at Cornell Medical College, and, in over *5,000* applications, not a single case of dermatitis has developed.

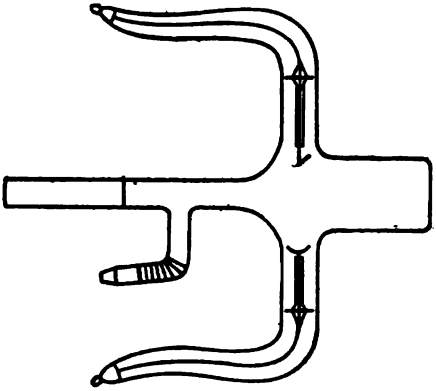


Fig. 85.—Cornell X-Ray Contact and Cavity Tube.

(This is a small focus tube, through the terminal end of which the rays are projected; the rest of the tube being made of lead glass to prevent any transmission of the rays.)

A METHOD OF DEEP ROENTGEN IRRADIATION WITHOUT INJURY TO THE SKIN.

Dr. Alban Höhler, of Wiesbaden, says:

The following is a description of a method for introducing considerable doses into the deeper tissues without injury, and for securing protection against Roentgen burning.

By irradiation without a filter, we are in danger of burning the skin and producing severe ulceration; whereas, if a filter is used, although we are enabled to introduce the rays without injury to the skin, they are so much reduced in intensity that they exercise a stimulating rather than an inhibiting and destructive influence on the organ.

I shall endeavor to describe a method, by which, the dose could be increased fifty fold without permanent injury to the skin. However necessary a small radiating focus may be for skiagraphy, it possesses no advantage for radio-therapy. I have, therefore, had a focus tube constructed, in which, the radiating surface of the anticathode is from one to one and a half c. m. in diameter. With this tube, I employ a wire gauze screen, with fourteen meshes to the inch, such as that used for wire blinds. A gauze may be made of somewhat thicker lead wire, or best, of platinum. The gauze is laid on the skin, or, with the interposition of a thin leather screen, and the focus tube is adjusted a few c. m. above the gauze. By this device, we obtain a perfectly uniform irradiation at a certain definite depth,—as uniform as if there were no metal network. The gauze, nevertheless, enables us to give much more considerable doses of *x*-ray without danger of producing an ulcer.

While each individual cell of the tumor or deep tissues receives an equal irradiation, the skin itself is irradiated only through the meshes of the net, and the cutaneous cells, directly under the wires, are protected from the rays. With this intense irradiation, the portions of the skin exposed through the meshes of the net are entirely destroyed; but these small necrotic areas will heal in a few weeks, since each necrotized point is completely surrounded by uninjured cells and vessels.

The same principle obtains as in the punctiform cauterization of an angioma with the Paquelin cautery. The remarkable rapidity with which such punctiform sloughs heal is well known. It is of advantage that the gauze and filter should be pressed close to the skin. This may be done by the compression screen. Focus tubes, with large focus, adapted for use by this method are constructed by Reiniger, Gebbert and Schall, of Erlangen.

This raying is especially adapted to the treatment of deep organisms.

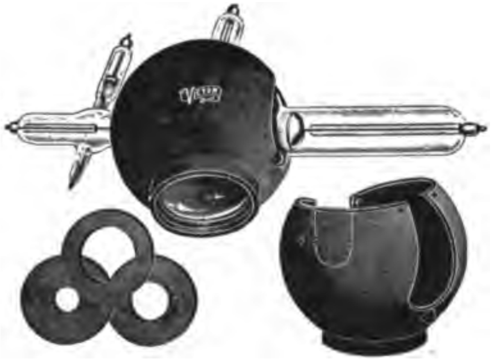


Fig. 86.—X-Ray Tube Shield.

X-RAY FLASHES.

In contradistinction to the usual continuous application of the *x*-ray Dr. Finley R. Cook, of New York, has introduced a method which he calls Roentgen ray *flashes* or *intermittent* *x*-rays, and claims for this certain advantages, as detailed.

By making and breaking the primary current, thereby securing flashes, it is possible to shorten the distance of the tube, greatly increase the amperage, eliminate the danger of the accumulative effect, secure greater penetration, and at the same time obtain a far greater degree of stimulation than has hitherto been possible with the continuous rays.

The degenerative action of the continuous and the regenerative action of the intermittent rays were first demonstrated in the eye. If a cataract approaching maturity were exposed to the continuous rays, an ephemeral stimulation and improvement in vision was sooner or later followed by ripening through hyperstimulation or irritation. This discovery led to the development of a technique for maturing a cataract for extraction.

With flashes, however, although using much greater amperage, irritation and ripening were avoided in such cases, and in incipient cataract not only a purely stimulating and regenerating action was invariably obtained with more or less improvement in vision, but this effect could be maintained throughout the entire course of treatment.

In the organs of special sense, blindness and deafness have resulted after a prolonged treatment for recurrent cancer in close proximity to the eye and ear.

The *regenerative action of flashes* is both local and general and is accomplished principally through their action upon the blood vessels. They dilate arteries, lower blood pressure, and induce an active and natural hyperemia. They stimulate cellular metabolism without exhaustion. In the eye, this regenerative action can be obtained in the cornea, iris, crystalline lens, choroid, retina, and optic nerve.

With a high tube focused over the chest and abdomen, the pulse rate has been lowered ten beats per minute, and the blood pressure ten manometers with one instantaneous flash. With sixty such flashes, a fall of sixty manometers, and thirty-five in the pulse rate has been accomplished in a minute and twenty seconds.

The discovery by Dr. Cook of the regenerative influence of x-ray flashes in degenerative conditions of the eye has led to its employment in more than a hundred cases which are now being prepared for publication. These cases include atrophy of the optic nerve, detachment of the retina, chronic glaucoma, cataract, keratitis, leucoma adherens, staphyloma, chronic iritis, iridochoroiditis, and impairment of vision not associated with any specific local disease.

In a number of cases where the blindness was of such a degree as to necessitate the use of a guide, sufficient restoration of sight has been given to enable the patients to be independent and to read ordinary print. Perception of light has been obtained where it had been lost for twenty years. In one case, where vision was only perception of light for a period of eight years, it was restored to that of reading large print in one treatment. In one case, where vision was zero, and had probably been so for twelve years, ability to count fingers and read large type at close range was obtained after two week's treatment. In several cases where vision was only perception of light for less than two year's duration, ability to read large type was obtained.

Roentgen-ray flashes are made by a special apparatus. It consists of a small motor, a condenser, and a moving shaft. It can be regulated to give from sixty to six hundred flashes per minute.

In a general way, we may state that it is our conviction that the evolution of Roentgen-ray flashes eliminates the danger of *x*-ray treatment.

While *x*-ray flashes may possibly lessen the danger of burning, I cannot believe that all the risk is "eliminated." (C.)

COMPARISON OF THE X-RAY WITH OTHER FORMS OF RADIANT ENERGY.

William Benham Snow, of N. Y., comparing the *x*-ray with other forms of radiant energy says: A remarkable contrast exists between the ultra-violet and the *x*-ray; the latter are not "sorted out" from one another, but go straight on without any deviation whatever. Sir Oliver Lodge describes it as follows: "It is simply a solitary wave, a solitary pulse, up and down almost instantaneously, and no more; nothing continuous, not a succession of waves—a solitary pulse, one splash like a whip-crack just again and again. With every blow of an electron, the derived *x*-rays proceed from the target in very rapid succession in all these flashes or cracks, because the electrons or cathode rays are bombarding the target in very large numbers.

For the explanation of *x*-ray action we used the word 'ionization'—it ionizes the air—renders it conducting; and when the air is made conducting, of course, no electroscope nor anything else can hold a charge. How is air rendered conducting? By breaking up a molecule into atoms. Ionization is the chemical name—quite an old idea for breaking up molecules into atoms. It is the kind of action that must go on in any electrolyte.

Air is not a conductor, because, as a rule, it is not ionized; but if any cause breaks up the molecules into ions, air becomes a conductor. X-rays are very powerful for this purpose, and so are cathode rays.

Ultra-violet light bronzes and blisters the skin to a marked degree, whether from sunlight or to a still greater degree from the electric arc, because the radiations from the arc are richer in violet rays. If you cut the heat off by passing these through cold water, the effect is the same. Treating the subject from the standpoint of radiant energy, combining the heat and the light rays generally employed, the effects of the heat rays are also present, while the *x*-rays are devoid of heat rays.

The dermatitis which is produced by the Roentgen ray is undoubtedly due to the inhibitory effects upon the cells, with the production, when carried far enough of tissue necrosis, arising from the induced activity of the functions of metabolism, by which means the tissues are starved, with resulting death; while the dermatitis arising from the influences of radiant light and heat energy are due, on the contrary, to the over-stimulating action of the radiations—the one producing dermatitis by inhibition and consequent starvation, the other by over-stimulation. The writer was impressed with this truth more than three years since, and has verified it constantly in the treatment and prevention of *x*-ray dermatitis. Intense light from the arc of a marine searchlight was employed at first on the same day following the *x*-ray exposure, with the expectation that it would act to prevent a dermatitis without interfering with the efficient effects of the *x*-ray. This, however, was found to be a mistake except when employed with the ray for the relief of deeply-seated malignant processes, the superficial cases not improving under the combined treatment, thereby demonstrating that the effect of light was to offset effects which we sought to obtain from the *x*-ray, except in tissues to which the light did not penetrate.

The later experiments of Dr. Edward Titus, in which he succeeded in restoring the power of germination to seeds and eggs which had been exposed first to the *x*-ray and then to light, while controls which had been exposed to the *x*-ray only failed to give any evidence of developing, seem to be conclusive. These observations verify the results of the writer's experience: that in tissues exposed on the same day to both the *x*-ray and light, dermatitis was prevented for more than four months under conditions that would ordinarily have produced it within six weeks, as it had previously in the same cases.

The physical effects of the *x*-rays are unquestionably demonstrated to be inhibitory. Sterility seems to have been produced in all animal and vegetable kinds in which investigations have been made.

The employment of intense radiant light and heat, which in the author's experience has been found of remarkable power in restoring to the tissues the normal activities, as of the perspiratory glands following the use of the *x*-ray, and also recuperating tissues rapidly after an *x*-ray dermatitis, has so often been demonstrated that its value under these circumstances cannot be questioned.

The indications for the use of radiant light and heat include, as suggested, (1). The relief of all conditions arising from exposure to the *x*-ray in which the processes of metabolism have been inhibited, as when there is sterility, lowered vitality of tissues, or when the secretions or other functions have been suspended. (*2*). These forms of radiant energy are valuable in conditions of poor metabolism in which the secretions of the skin, from any cause, have become inactive, or where an inactive elimination by all the emunctories is indicated, as in Bright's disease, rheumatism, or gout, in which conditions its actions are undoubtedly superior to dry hot air, embracing as it does the influence of both light and heat upon the functions of metabolism. (*3*). In arteriosclerosis and in other conditions where the heart is working against a condition of high arterial tension, when it relieves the labor of the heart by dilating the capillaries, thereby increasing the circulation in the periphery of the body. For the same reason, it is indicated in all septic and toxic processes, favoring in a large degree the elimination of the products of infection. (*4*). The application of light and heat radiations by the employment of localizing lamps, are remarkably efficacious in the treatment of local infections and inflammatory processes. For this purpose the local uses of such means as the swinging incandescent lamp renders valuable service. These lamps, to be effective, should be of high candle power.

RADIO-THERAPY AND PHOTO-THERAPY.

Sidney Stephenson, of London, gives a very important review of the present status of these valuable agents in therapeutics under the title,—"Some of the Newer Remedies in Eye Work."

He says: Attention has been recently paid to the treatment of affections of the eye and its appendages by radiations of various kinds, including those of electric lamps, *x*-rays and radium.

As regards *photo-therapy*, L. Koch obtained good results in some cases of keratitis and of serous iritis by exposing the eye twice a day for about five seconds to the light of an electric lamp of about *20* c. p. Some slight effect also was obtained in opacities of the cornea. D. E. Sultzer has attempted to resolve opacities of the cornea by exposure of the eye to the radiations of the arc lamp of Broca Chatain. The eye was placed at the conjugate focus of the arc light, formed by a quartz lens which had a diameter of *40* m. m. and a principal focal distance of *50* m. m. The exposure varied from *20* to *90* seconds, depending upon the reactional susceptibility of the patient. Reaction was proportional to the length of exposure to the actinic rays. It supervened in two hours to two days under the guise of redness of the eye, lacrimation and lancinating pains. He found that interstitial sclerosis of the cornea improved, that tension fell, and that pupillary exudations were absorbed and posterior synechia underwent rupture. Nineteen cases were quoted in support of his conclusions.

Sulzer has treated corneal opacities by electrolysis applied directly to the cornea by means of a negative silver wire *1.50* m. m. in diameter,—the end of which had been fused to form a bead. A current of *110* volts was used, and the voltmeter should register 4 to 6 volts. The results in nebulae of the cornea were good, the appearance of the eyes was always improved, but bettering of the sight was not so pronounced, but vision below *1/10* was raised to *2/10* or *3/10*.

Light Treatment.—Hertel has treated ulcus serpens cornea (hypopyon keratitis) by that means. Of *547* cases, *26* were cured with the light rays directed from a kind of modified Finsen lamp. Exposures ranged from *3* to *5* inches, and, as a rule, sittings were required several times. Reaction was pronounced. The resultant scarring was very slight after the treatment by irradiation.

X-rays as well as currents of high intensity, (frequency?) have been widely employed in the treatment of diseases of the eye, sometimes with the best results.

Birch-Hirschfeld sounds a note of warning, that unless used with proper precautions, *x*-rays may cause most untoward complications, as for example, loss of the eyebrows and lashes, conjunctivitis, keratitis, and iritis, degeneration of the muscular region and ganglionic layer and vessels of the medullary fibres of the optic nerve. He urges, therefore, that the eyeball should be efficiently protected and that exposure should neither be unduly long nor repeated too often.

The list of diseases that have been treated by the *x*-ray includes: (*1*). Rodent ulcer and epithelioma. Sweet, in *20* such cases, cured *18*, and he is of the opinion that it is no longer justifiable to resort to excision.''

While the utmost caution is advisable as urged, the fact is that the eye bears exposure to the *x*-ray better than the integument, and that the expert operator may have little fear of injuring it. (Coleman.)

Sarcoma.—Webster Fox restored to normal an inoperable case, after 46 exposures to the focus tube. Kienbock cured a sarcoma which had produced bilateral exotropia and optic atrophy by 13 exposures, spread over the course of three months.

Trachoma.—Walsh, and the reviewer, Stephenson, were the first to apply the high-frequency current in this intractable disorder. The results were excellent and cure was obtained always without pain and often in a surprisingly short time. It seemed to make little difference whether the current was applied directly to the diseased parts or merely transmitted to them through the closed lids. The tediousness of holding the lids everted, as well as the exposure of the nurse's hands, may be avoided by applying the little clip of Reid and Edmund's. Harman treated 7 cases of trachoma without improvement with the high-frequency current.

Tuberculosis of the Conjunctiva.—The reviewer was the first to endeavor to cure this somewhat rare disease by means of the *x*-rays. This patient, aged four, was cured in a month, without visible cicatrization of the conjunctiva, by thirteen exposures applied for ten minutes at a time, the tube being 6 inches from the eye.

Aubineau and Chuiton had a successful case which the actual cautery and silver salts had failed to cure.

Spring Catarrh. — Recoveries from spring catarrh, by exposures to the *x*-ray, have been reported by Starr, Bennett and Allport. The latter first removed the palpebral outgrowths and then exposed the conjunctiva, everted by means of a lid clamp. Cure followed eighty exposures.

THE EMPLOYMENT OF THE CALDWELL CAVITY TUBE AS A SURFACE ELECTRODE.

Dr. Charles Rea Dickson of Toronto, Canada, testifies to the value of this tube, saying, in part,—The Caldwell tube was designed for therapeutic applications of the Roentgen ray to the larynx, tongue, etc., and in the catalogues of manufacturers is sometimes alluded to as being an ideal tube for the treatment of small growths on the surface of the body.

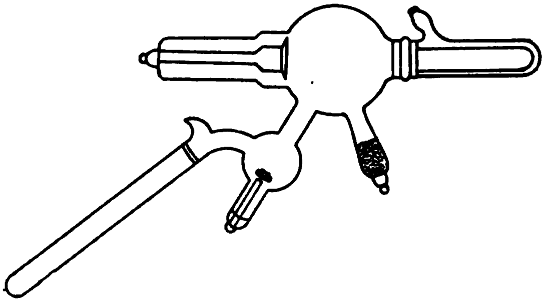


Fig. 87.—Caldwell Cavity Tube.

In the treatment of a case, the parts to be dealt with are first cleansed and rendered aseptic; if crusts are present they are carefully removed; some preparation of the supra-renal gland is next applied to blanch the surface and favor penetration of ultra-violet rays, and if the parts are sensitive, a local anesthetic such as cocaine or eucaine is applied.

The tube is then sterilized, a convenient method being a careful washing with Lysol, used full strength. The portion of the tube in contact with the lesion and adjoining portions must be cleansed occasionally during the treatment. With the patient placed in a convenient position and uninsulated, the discharging rods of the static machine are closely approximated, the positive pole of the machine grounded and the machine set in action.

The tube is connected with the negative pole of the machine by the cathode terminal and held closely in contact with the part to be treated, its target facing the lesion and the insulated handle adjusted to a suitable position. The anode is not connected to the machine nor grounded, but left free, its terminal should be insulated with rubber tubing or otherwise to prevent sparking to either the patient or operator.

The discharging rods are next slowly separated until the portion of the tube permeable to the *x*-ray exhibits a rich greenish-yellow glow; the tube is then moved slowly over the entire surface of the lesion, pausing for a few seconds at each change of position, devoting from one-half to five minutes—rarely the latter—to each square of surface, according to the condition of the part and the depth and gravity of the lesion.

Having thus gone over all the surfaces to be treated, the discharging rods are still further separated, until there is a distinct sparking from the tube to the lesion, when all portions of each lesion, or those portions which will tolerate it, are again gone over with a gentle patting motion for a similar time.

Treatment should not be administered strong enough nor continued enough to cause vesication.

The effects produced by this form of procedure are briefly those of a combined *x*-ray; blue-violet and ultra-violet rays, low frequency, high potential static charge and sparks.

We have thus the mild irritant and ionizing effects of the *x*-ray and ultra-violet; the sedative action of the violet rays; the markedly tonic effect of low frequency, with its relief of congestion and stasis and liberation of ozone and nitrous acid, with their oxidizing, ozonizing and antiseptic properties, aided by the germicidal action of the ultra-violet; and, lastly, we have the pronounced stimulating action of the static charge and sparks on tissue metabolism.

One case I quote,—of an oblong epithelioma of the lower lid, about three-quarters of an inch by one-quarter of an inch in extent. This had been irradiated as usual five times previously, but the convenient shape of the cavity tube, if for no other reason, was a great improvement in getting at an awkward locality and emphasized the utility of the tube. After two of the surface tube applications, healing was complete.

By "target," Dr. Dickson doubtless means the tubular treatment-end of the main tube, as there is no metal target in the Caldewll Cavity Tube.

Having a naso-pharyngeal sarcoma to treat, I ordered a Caldwell Cavity Tube made specially, with an automatic regulator to lower the vacuum; but, finding that, as there is no metal target, only a very moderate amount of x-rays is transmitted, I was obliged to substitute a Cornell Tube.

For cases which require the combined use of moderate x-ray and high-frequency effluve, the Caldwell Cavity Tube offers special advantages.

X-Ray in Medicine and Surgery.—Byron Davey, of New York, reviewing a year's work in the Post Graduate Medical School and Hospital, says that it has been their procedure to begin the x-ray treatment of each case with exposures of five minutes. If, after two treatments, no symptoms develop, the time is extended to ten and usually to fifteen minutes.

Should pigmentation, erythema, and dermatitis develop, one must wait till it subsides, usually not more than a week, and begin again with the maximum time exposure that can be borne with safety.

Epitheliomata.—He recalls no case in which there was no implication of glands, which has not responded readily to the *x*-ray.

Goitre.—There were five cases attending the clinic at one time, two of the five showed marked improvement. On the other three, the ray had no noticeable effect. Those responding were simple hyperplasias of glandular tissue.

Tubercular Glands.—The results of treatment with the *x*-ray have been all that could be desired.

Lupus.—In cases where no improvement has been noticed after six to eight exposures to the *x*-ray, it is considered that the condition is complicated, usually with syphilis. Specific treatment, combined with the *x*-ray, will effect a cure.

TREATMENT BY X-RAY AND HIGH-FREQUENCY SPARKS.

Samuel Stern, of New York, reports the results of eight hundred cases of cutaneous disease, treated at the Lustgarten clinic, with the *x*-ray and sparks of high-frequency. The superficial epitheliomas, he says, give the greatest success, while there is little hope in the deep epitheliomas. He considers it best to combine the *x*-ray and the high-frequency sparks.

Little success was found in sarcoma.

Lupus vulgaris of the mucous membrane requires the *x*-ray alone, while the lupus of the skin requires the sparks of high-frequency.

In keloids, the *x*-ray must be continued until there is slight dermatitis.

Shepherd, of Montreal, says that in certain cases of epitheliomas, especially of the lids, the *x*-ray constitutes the best mode of treatment.

Albert C. Geyser, of New York, writing of lupus vulgaris, says that a recent method has been to treat cases with the x-ray until the reaction necessitates their stoppage, when the brush discharge from metallic and wooden electrodes is substituted. Cases treated in this manner have recovered more promptly than when the ray alone was used. When it is desirable to set up a strong counter irritating effect, the x-ray is used until a condition bordering on dermatitis is induced. When the tissues recover from this effect, the lupus disappears with it.

Other cases are treated with the brush discharge from a wooden electrode of soft maple, because this discharge is more beneficial than the metallic spray.

Still other cases do better when the combined method is employed, especially when there are certain unfavorable areas,—as the margins of the lesion in some intractable cases.

Method of Treatment.—After experimenting with various substances, Geyser adopted sheet rubber for the purpose of the protection of the patient. As shields, they effectually absorb the rays and prevent dermatitis.

He recommends, unhesitatingly, the specific action of the x-ray with the substitution of the brush discharge from a wooden ball electrode, at the proper time; thereby avoiding undesirable results from prolonged use of x-rays.

Illustrative Cases.—Lupus vulgaris began at the age of thirteen, upon the cheek, gradually spreading until it was of seven years standing. Treatment consisted of three exposures to the x-ray, with four inch spark gap; distance from the tube was six inches; rubber shield. A slight dermatitis resulted. The patient was then treated three times weekly, for one month, with a brush discharge and has remained well for more than a year.

EPITHELIOMA, TREATED WITH THE X-RAY. RESULTS AND TECHNIQUE.

Emil H. Grubbe, of Chicago, an acknowledged expert in *x*-ray treatment, writes,—Probably in no disease has the *x*-ray demonstrated its peculiar power better than in the treatment of epithelioma.

We wish emphatically, to refute the statement that the high tube is not so dangerous as the low tube. Nothing more fallacious can be announced. It certainly is not proper to use a high tube when a low tube will answer the purpose; nor can one without an accompanying danger. A tube, whose vacuum is just high enough to penetrate the tissues to be affected, should always be used. A higher tube would penetrate undesirably deeper tissues.

We have no absolutely accurate method for determining the relative vacuum of a tube. The simplest method is to rely upon the ability of the tube to back up a spark gap between the prime conductors of a generator. One writer calls a low tube one whose vacuum is equivalent to an air spark gap of less than three inches. Such a vacuum we use in epithelioma. Since it is our aim to produce dermatitis in all these cases, treatments are given daily, exposures being ten minutes, with the tube placed from four to six inches from the affected part. When redness, heat and itching occur, in the parts exposed, treatments are stopped for two to seven days, according to the degree of reaction.

Only those who have had sad experiences with the use of the high tube can appreciate the danger to which we subject patients in every exposure.

After the first reaction, there is usually less liability to active dermatitis. In all unbroken conditions, a continuous presence of dermatitis is of great value and will accomplish more than when we do not produce it. In all open or ulcerated conditions, we need not stop at producing a simple dermatitis; in fact, then, when we are just beginning to do the condition good, if we continue treatment until an actual burn develops, all will be surprised at the good results.

Proper general treatment is as much indicated when the patient is under *x*-ray treatment as at any other time. We have treated one hundred and three cases of epithelioma with the *x*-ray. In about half of the cases, the disease has been upon the surface. The patients range in age from eight to ninety-two years. The average length of time under treatment was four months. The cases include both primary and post-operative. In seventy-six cases, the disease was located on some portion of the head. The part most affected was the mouth,—sixty-eight cases. In eight cases, involving the eye, the results were considered good in five; poor in two; there was a failure in one.

In thirteen cases, involving only the tongue, the results were considered good in seven; poor in two; failure in four. In twenty cases involving the fauces, results were fair in six,—the disease seems to have been checked—poor in six; failure in eight. In twenty-two cases involving the nose and cheek, results were good in ten; poor in seven; failure in five. In twenty-one cases involving one or both lips, results were good in ten; poor in seven; failure in four.

All cases of epithelioma of the fauces have been benefited at the beginning of treatment, but we cannot report any permanent cures. In all uncomplicated cases of superficial epithelioma, where the diagnosis had been made early, the desults due to *x*-ray treatment have been such as to warrant the use of the word cured, in its fullest sense. Every surgical case should be placed under *x*-ray treatment within from one to three weeks after the operation.

Burdick, of Chicago, writes,—"I do not try to produce a dermatitis. When I get a bronzing of the skin, I stop treatment until I see just how far the irritation will extend."

C. E. Skinner says,—"In some cases, it is necessary for the production of a cure to cause dermatitis, but not in all."

X-Ray After Operation as a Preventive.—W. B. Wetherbee says,—"When the growth recurs, it might have been prevented in a certain percentage of cases, by destroying, with the *x*-ray, the cancer cells that remained in the tissues adjacent to the growth. This treatment is not indicated when the cancer cells have invaded distant parts, except as a palliative. The patient should be teated the day following the operation. The open wound facilitates the direct action of the ray on the remaining cells and affords a free drainage."

Stover, of Denver, cites a case in which a mole on the side of the nose took on malignancy. It was excised, but recurred. After twenty-six treatments by the *x*-ray, recovery was complete.

CHAPTER IV.

OZONE.

THE PRODUCTION AND USE OF OZONE.

Owing to the stresses set up in the air surrounding a conductor charged with electricity, certain changes are induced in the air, which, in this instance, is serving as a dialectric: the most important of which are the production of nitric acid and ozone. Under ordinary conditions, the amount of these products is insignificant, but, with high tension currents, they become a factor of some importance, as they exercise a corrosive action on the apparatus. This incidental effect of a current of electricity was first noticed in operating the so called static machines, and, later in the *x*-ray coils and high tension systems. As these types of apparatus came into more general use, these incidental products, which, at first, had been of interest only on account of the peculiar odor noticeable about the machines while in action, became of importance from their destructive effects and led to a more careful study of their cause. As a result, not only was it found that their production could be materially lessened by suitable changes in the construction of the apparatus, but that the quantities produced could be materially increased. From this beginning, have been evolved several types of apparatus capable of producing nitric acid and ozone in commercial quantities and suitable for industrial uses; chief of which at the present time is the purification of drinking water and the manufacture of fertilizers. The instrument makers have already put at our disposal several types of apparatus capable of producing ozone in sufficient quantities to

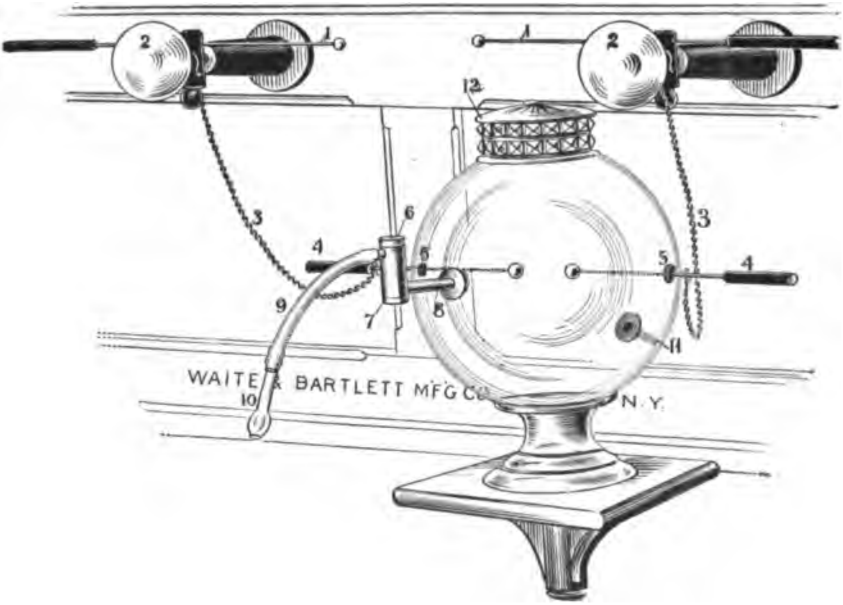


Fig. 88.—Ozone Generator for Use With Static Machine.

make it available for therapeutic purposes. The essential feature of the apparatus for the production of ozone is the silent discharge from a current of moderately high tension. When an alternating current is available, a general type of apparatus consists of a step up transformer of about *12,000* volts, the secondary terminals of which are provided with a series of needle points and are kept apart just far enough to prevent a spark passing. Similar apparatus is made to be used in connection with an *x*-ray coil and Oudin resonator, or any similar high tension apparatus, and consists essentially of wire or tinsel brush terminals for the high tension current enclosed in a glass jar and provided with an adjustable spark gap in shunt circuit as a means of regulating the current. The ozone generator jar is connected by means of a tube to a jar containing an aromatic volatile oil or a simple alkaline solution in order to filter out the traces of nitric acid that are produced together with the ozone; and a fan, driven by a small motor, is employed to cause the continuous passage of the current of air through the ozonator.

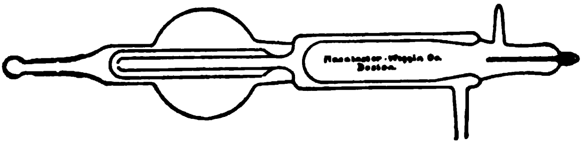


Fig. 89.—Ozone Generator to Operate on High-Frequency Coil or Static Machine.

The commercial types of apparatus in the sterilization of public water supplies are in successful use. The medical apparatus has proven of some value in sanitarium work and gives considerable promise of being of decided value in those types of disease dependent upon sub-oxidation. Among the claims mentioned by the devotees of this form of treatment, are its successful use in the various types of germ infections, neuresthenia, nervous asthma, nervous impotence, anaemia, and the toxaemias of insufficient hepatic and intestinal metabolism.

The further claim that the oil from the filtering jars makes a valuable dressing for obstinate ulcers and chronic skin diseases, owing to the large amount of ozone retained therein, is open to criticism. As these oils are in the apparatus for the purpose of absorbing the nitric acid, it is more rational to ascribe any virtue they may possess, as a dressing, to the stimulating effects of the acid.

OZONE IN MEDICINE.

Dr. S. St. J. Wright, of Akron, Ohio, who is an ardent advocate of the value of ozone in certain nasal affections, presented its claims before the Am. Electro Ther. Ass. in *1909*, substantiating his arguments with several illustrative cases, as follows,—

Case *2*. B., aged *11*, drooled and snored at night; a mouth breather; unable to force any air through either nostril. Has adenoids; profuse mucous secretion. The inhalation of ozone was used and the Oudin current was conducted to the naso-pharynx by insulated bell wire, inserted into each nostril to the vault of the pharynx for one-half minute, carrying the high potential current by one wire—the other being grounded.

Breathing was normal after three treatments. Hearing returned promptly; and, after nine sittings, the lad's speech, hearing and appearance were normal. He has remained well for ten months.

Case *3*. Treated by ozone alone—aged twenty months. Unable to breathe through either nostrol; profuse flow of pus from the nose.

Two inhalations of ozone, for ten minutes each, removed every morbid trace on the third day.

Ozone, Dr. Wright considers, seems to sterilize infected accessory sinuses.

As the subsequent discussion throws profitable sidelights upon this subject, beside showing the experience of other experimenters, we will quote next Dr. W. J. Morton, of New York,—who says,—

"The writer of the paper attributed his splendid results to ozone. He referred to ozone as having been produced in the open atmosphere by the disruptive spark. True, ozone was produced, but the spark will produce, under the circumstances named, nitrous acid as well. Dr. Wright neglects the consideration of the possibility that the curative results were due to nitrous acid."

Dr. Morton said that, in previous years, when he produced ozone, he had passed the first product of the modification of the atmosphere through sodium to remove the nitrous acid. When he did this, and administered pure ozone, he did not get the therapeutic results which he had obtained when he used the compound of ozone and nitrous acid. He would suggest that nitrous acid may have had much to do in producing the results claimed by Dr. Wright.

Dr. W. Benham Snow, of New York, said that with the unsatisfied atom, ozone was so ready to attack organic matter that, while the agent used was supposed to be ozone, it was practically not ozone at all, after it had passed through the oils, and the effect produced was probably not due to the ozone.

Dr. Wright, in reply, said that the inhalation of ozone sterilizes the mucous surfaces of the nose and throat, and eliminates the products of imperfect metabolism, thus removing the cause of hypertrophy. If to this, you add the influence of the current of high potential conducted to the adenoid tissue, by an insulated wire along the anesthetized floor of one nostril, the obstruction disappears. He does not call it a surgical operation of any kind.

CHAPTER V.

SPECIAL ARTICLES.

ANAESTHESIA.

To anaesthetize a furuncle, Scheppegrell directs that a ten per cent solution of cocaine be applied to it; then apply the positive electrode, with one half a m. a. for five to ten minutes.

To anaesthetize the membrana tympani, use solutions of five to ten per cent and the current applied for ten to twenty-five minutes.

Electro-Cocaine Anesthesia.—Morton, of New York, applies a ten per cent. solution of cocaine to the part to be operated upon; the positive electrode being saturated with it and a current of five to six m. a. being given for five to eight minutes.

When warty growths are to be treated, or lupus, etc., he uses zinc needles on the positive pole for growths and a copper bulb electrode in lupus. He finds results are favorable.

Guiacol.—In local anaesthesia, Morton also finds guiacol valuable. The solution includes guiacol ninety per cent., cocaine hydrochlorate anhydrous ten per cent.

He found that the addition of the guiacol, in producing anaesthesia, both shortened the time two-thirds and reduced the quantity of necessary current two-thirds.

Guiacol is not only anaesthetic but is also a valuable antiseptic.

Electric Sleep.—Writing of electric sleep, C. H. Hughes, of St. Louis, says: Leduc, of Nantes, tried it on himself with complete success. All we require is a means of obtaining the continuous current;

a voltmeter and a milliampere meter. An interrupter is also required.

The awakening from sleep was instantaneous and the immediate feeling was one of comparative well being.

One electrode was fastened to the head and the other over the kidney region.

Dr. Petit says that it is free from risk.

TREATMENT OF CANCER BY CATAPHORIC STERILIZATION.

Dr. G. Betton Massey advocates the treatment of cancer by cataphoric sterilization. He says:—The electrolytic and phoretic powers of a strong electric current are utilized to dissolve and ionize zinc points or needles coated with mercury. These points are thrust into the growth and an amount of ionized mercury and zinc is thus interstitially diffused throughout the tumor, in a few minutes, in sufficient quantity to kill all malignant cells and their accompanying germs. By prolonging the process, these microbicidal substances will be driven further than the apparent boundaries of the growth in sufficient strength to kill outlying colonies and lines of dissemination in the immediate neighborhood, without serious detriment to healthy tissues. In other words, while all tissues will be necrosed *en masse* near the electrode, the diffusion may be so regulated that a sufficient quantity of ions will pass beyond the line of necrosis and kill outlying cancer cells, without being more than highly irritating to normal cells. They form a narrow zone of sterilization beyond the area of necrosis and only a small portion of the chemicals are absorbed into the general system. In *1896*, a current of *1000* m. a. was applied in a bipolar manner, several zinc-mercury needles being connected with each other and with the positive pole. These needles were thrust into the periphery of the tumor, while the circuit was completed with a cotton covered disc saturated with Fowler's solution and connected with the negative pole, which was placed against the centre of the growth. This resulted in the diffusion of zinc-mercury ions from each anode and of arsenic ions from the cathode. The operations were performed while the patients were under a general anesthetic.

Results.—Cases inoperable by the knife have been the author's source of material. Under such conditions, it has been most gratifying, in reviewing his more than fourteen years work, to find that a large percentage of the patients have been greatly benefited; that a very small percentage have not been benefited or have been made worse; and that a few have had their lives saved and have been actually cured, when this result could not possibly have been secured by the use of any other known means.

When there is no lymphatic involvement, cancer of the face is best treated by cataphoresis.

1. Because only diseased tissue and a small amount of healthy tissue are destroyed.

2. Because the resulting scar is less conspicuous than by any other method, except possibly by the x-ray.

3. Because the danger of malignant implantation is eliminated.

Before use, the zinc needles are amalgamated with mercury by first dipping them in ten per cent of acid sulphuric. The slough which occurs comes away in from *7* to *21* days. The current is kept up until a grayish discoloration (of necrosis) includes the whole growth as well as a small amount of healthy tissue.

In some cases, in which the current is not well borne, the bipolar method is useful, as it does not embarass the heart or respiration, and practically any strength of current may be borne, thereby shortening the time of the operation.

ELECTRIC LIGHT IN THE TREATMENT OF SYPHILIS.

Dr. Finkelpearl, of Pittsburg, writes:—The latest arrival with strong claims for an important position in the therapeutics of syphilis is the energy of light.

Although the reporters on the light treatment of syphilis are few and statistics on this subject rather meager, the fact that the reports come to us from such eminent authorities as Cleaves, Kellogg, Strebel and others, should be sufficient to encourage the medical profession to give electric light a fair test in the treatment of this formidable disease.

Dr. Margaret A. Cleaves, in her work on the energy of light, speaks in glowing terms of solar and electric light as a curative agent in syphilis. The same author reports a severe case of tertiary syphilis, which resisted the mixed treatment, *x*-ray and brush discharge, but yielded promptly to the combined use of arc and incandescent light. Dr. Kellogg, in his work on rational hydrotherapy, claims for incandescent light baths great virtues in the treatment of syphilis, particularly in the third stage.

Dr. Strebel reports good results from the use of ultra-violet light in the treatment of primary syphilitic sores and gummata.

Dr. Below of Berlin reports a number of cures of syphilis by means of the electric light bath.

The encouraging reports above cited and others met with in medical literature led me to install an outfit consisting of one cabinet for the administration of arc light, and one for incandescent light baths.

Feeling that we have not sufficient data on this subject to justify us in risking the future welfare of our patients by relying on electric light alone for the complete cure of this disease, I thought it best, for the present at least, to use it only in conjunction with, or as an adjunct to, the standard remedies, and compare the results of treating syphilis by drugs alone with the results of treating by drugs plus electric light. The number of patients treated by light was thirty-two. The time of each exposure was ten to thirty minutes, repeated every two, three or four days. The incandescent cabinet contains three rows of thirty-two candle-power lights, each row containing six lights, and three rows of sixteen candle-power lights, each containing six lights. The arc cabinet contains two lights of six amperes each taken from the alternating current.

From the five cases reported by Dr. Finkelpearl, I select this illustrative case to show the effect of treatment by light, after the classical treatment by drugs had failed to effect improvement.

Case *1*.—F. D., aged thirty-two. Contracted syphilis in *1898*. His face, neck, and particularly his back, were covered with cutaneous gummata ranging in size from a pea to a twenty-five cent piece. The lesions were so large that he could not recline in a chair or sleep on his back. The usual local applications were of no avail. The iodides were increased, decreased, and discontinued without any influence on the number and size of these tertiary cutaneous lesions. A course of baths at the sulphur springs of Mt. Clemens had almost no effect. The electric light treatment was instituted on December *3*, the patient taking twenty minutes of incandescent light bath. Three days later, he took the same for thirty minutes. On his third visit, December *10*, the patient showed some improvement, when he was given twenty minutes of arc light, followed by twenty minutes of incandescent light bath. A few days later, he reported that he could lean in a chair or lie on his back at night without any discomfort. After a total of fifteen incandescent and six arc light baths, covering a period of two months, the skin cleared up entirely. I see the patient frequently and am assured that there is no sign of any relapse. This is the only case that received no drugs since this form of treatment was begun.

Comparing the results of his five reported cases, also other cases which he treated by light or by drugs and light, with those treated by drugs alone, Dr. Finkelpearl summarizes his experience as follows,—

1. That the cutaneous symptoms disappear more rapidly by the application of the combined arc and incandescent light baths, and that the traces on the tissue are less marked where light is used.

2. That albuminuria and affections of the joints met with in the secondary stage, are removed quicker by the incandescent light bath.

3. That the enlarged glands diminish in size more rapidly under light, and that the pain of enlarged inguinal glands is very much relieved by the use of the glass vacuum electrode.

4. That although the patients who receive light seem to improve under smaller doses of mercury, they can take larger doses of the drug without being salivated, and that an already induced salivation is rapidly removed by from one to three incandescent light baths.

5. That the general health of the patient is much better when the patient is given radiant baths than when given Turkish or hot tub baths for eliminative purposes.

6. Although blood counts were not made, it was observed that the patient looked less anemic when the arc light bath was given.

7. That the effects of mercurial inunctions given immediately after a radiant bath and mercurial fumigation given while the patient is in the electric light cabinet, are decidedly greater than when given in any other manner.

NAEVUS TREATED BY ELECTRICAL METHODS.

H. Lewis Jones, of London, with an experience of sixteeen hundred cases of naevus, treated electrically, writes:—

In the days which preceded the modern development of x-ray work, and of ionic medication, it was a relief to turn from the routine of applying electricity to chronic nervous affections, etc., in order to treat a naevus by electrolysis and by the electro-cautery, and to feel that a visible and satisfactory result was sure of attainment, provided that the treatment was properly applied.

I am able, today, to present you with an analysis of sixteen hundred cases of naevus, that have passed through the electrical department of St. Bartholomew's Hospital, in the last eighteen years.

In all this long series of cases, there have been none in which the ultimate result has not been a good one, and, after a lapse of years, when I have seen a case again, I have been struck by the success which attends the electrical methods of treating naevi. In all the series, one death only—that of a weakly child—occurred.

Distribution of Naevi.—I consider there is no part of the skin of the body upon which a naevus may not occur.

Of the *1600* cases, *851* occurred on the face or head.

Of the *851* cases, *85* occurred on the eyelids; *75* occurred on the nose; *12* occurred on the ears.

Methods of Teatment.—Electrical methods have superseded the older procedures, and include the old established electrolysis and galvano-cautery and the newer high-frequency applications, x-rays and radium.

In the majority of naevus cases, it is imperative that the naevus should be got rid of with as little scarring as possible and it is this which makes the treatment difficult. The object desired is to produce little or no slough, but rather to set up a plastic inflammation which shall lead to obliteration of blood vessels without loss of tissue.

For routine treatment of naevus cases, in general, I do not consider electrolysis is quite so satisfactory as the use of the electro-cautery, if this is skilfully applied. With electrolysis, the close localization of the destructive effect to the immediate surroundings of the needles is a disadvantage where success demands an effect spreading into a zone all about the lines of puncture. This is more readily obtained by the use of a fine galvano-cautery point, which should be as fine as possible and should produce vertical punctures all over the naevus at about one-sixth of an inch apart, and rather more close about the margin,—which is the zone of active growth.

The treatment, be it electrolysis or cautery, must reach through the whole thickness of the growth. The scars, left by the galvano-cautery in early infancy, disappear almost entirely when the child has grown up. When electrolysis is the method chosen, e. g. in a subcutaneous naevus with sound skin over it, it may be done with needles attached to both poles,—the bipolar method,—or with a needle or needles attached to the negative pole only. The first is rendered easy by the use of a handle into which several needles can be screwed in such way that the alternate needles are of opposite polarity. In this method only platinum needles should be used. The advantages of the unipolar method are that more attention can be given to one needle and that it can be moved to different parts more easily. It also admits of the use of the positive pole with zinc needles.

After a prolonged experience of the use of electrolysis, which is of great value in certain cases, I have a preference for the galvano-cautery. Where a little fine work is needed, electrolysis with a single needle is the best.

For subcutaneous naevi, electrolysis with platinum needles is good. When the positive needles are of zinc or copper, metallic ions are deposited in the naevus and exert their special effect. With copper, there is a considerable risk of setting up sloughing; but, with zinc, this is much less marked, and I have some hopes that with these needles we shall find the best means of dealing with naevi which are partly or wholly subcataneous. The results, so far obtained have been very encouraging.

I believe no age is too tender to be treated. I have treated new born babies many times. The only exception I would make to early interference is in certain naevi of the forehead and of the nape of the neck. Children are often born with a superficial nevoid condition between the eyebrows or on the back of the neck or on the upper eyelid which calls for no treatment and will slowly fade in a few months.

A repetition of the operation for naevus has occurred in less than one-quarter of the cases. Except in the case of large naevi, as much as possible should be done at the first operation. The tendency to recur has very much decreased at the end of the first year.

Part III.

Electricity in Diseases of the Eye.

CHAPTER I.

EYELIDS, CONJUNCTIVA LACHRYMAL APPARATUS.

BLEPHARITIS MARGILALIS.

In severe cases, I use the *x*-ray and prefer it to other treatment.

Freund and Schift obtained cures with a few exposures to a hard tube.

Fox had uniformly excellent results with a high-frequency glass vacuum electrode applied directly to the lids. He tested this treatment in one hundred cases. The electrode should be applied before the current is turned on, in order to prevent sparking, and the treatment should be continued for five to fifteen minutes daily.

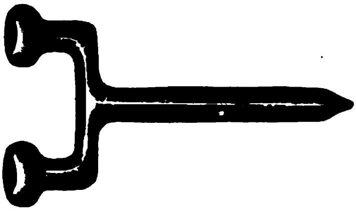


Fig. 90.—Binocular High-Frequency Vacuum Electrode.

Leprince and Pansier agree that in ulcerative blepharitis the galvanic cautery is indicated. They have usually obtained more rapid recoveries than with chemical caustics. The pain is not so severe.

Fiengal says that he prefers a slight electric cautery to nitrate of silver. The operation is less painful, reaction less, and recovery more rapid.

Rogers recommends treatment with the *500* c. p. incandescent lamp, and offers the following technic: The lamp should be placed quite closely over the eyes for a few seconds. This process should be repeated several times at each treatment, after which, an ointment of the yellow oxide of mercury may be applied, if desired. In many cases, it is necessary to remove the lashes.

HORDEOLUM.

In several cases, Allen found that the *x*-ray effected a rapid disappearance of the stye.

In the early stage of a stye, I have succeeded most effectively in aborting the process, in one or two days, by exposing the lids once or twice daily, for fifteen minutes to a *500* c. p. lamp.

DISTICHIASIS.

The removal of displaced ciliae is best accomplished by the use of an electrolysis needle. Operators differ slightly in their methods, but the following is the one I employ.

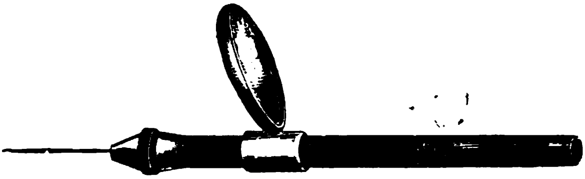


Fig. 91.—Electrolytic Needle With Lens.

I wear a pair of glasses + *6.00* added to the strength of my own correction and combined with prism of *3*°, base in for each eye. (These glasses will also be found invaluable in detecting foreign bodies on the eye, and in performing delicate operations.)

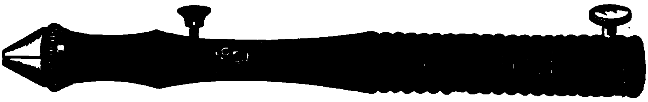


Fig. 92.—Needle-Holder With Interrupter.

A bulbous, pointed Hayes steel needle, half an inch long, is attached to the negative pole and inserted one-eighth of an inch by the side of the hair shaft, for twenty to thirty seconds. Using a current of one m. a., this will permanently destroy the growth of three-fourths of the hairs treated. Repeat the needling if the hair does not drop out readily when the forceps is used. If it is desired to prevent the pain of the operation, a two per cent. solution of cocaine in adrenalin (*1* in *1,000*) may be injected hypodermically along the margin of the lid.

If the lids are inverted, this procedure is not applicable as it will be necessary first to correct the position of the lid by surgical operation.

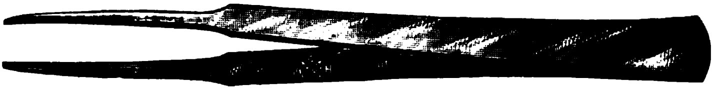


Fig. 93.—Cilia Forceps.

Hayes used a current of three-quarters to one and one-half m. a. and rarely three m. a. He considered the chemical action produced around the negative needle a much better index of the current required than is the milliamperemeter.

ALOPECIA OF THE EYELIDS.

Treated With the Sinusoidal Current.—Miss —, aged *16*, consulted me, having had complete baldness of the lids for a month. She had been troubled with the same affliction, at intervals, during four and a half years, and she had been treated with massage for five months without improvement.

I applied the sinusoidal current to the lids for ten minutes tri-weekly. After four months, the lashes were one-half their usual length.

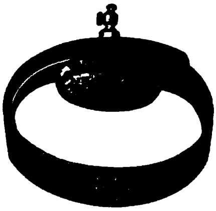


Fig. 94.—Wrist Electrode.

TREATMENT OF ECTROPION AND ENTROPION WITH THE CAUTERY.

Ziegler makes, in the former, with a galvano-cautery tip, a row of deep punctures, *4* m. m. apart and *4* m. m. from the margin of the lid, on the conjunctival surface.

In Entropion, similar punctures are made on the skin surface and repeated, if necessary, in two to three weeks. One to three sittings will accomplish as much as a plastic operation. Ice pads are applied for a few days.

In Ectropion, I have used successfully a linear galvanic cauterization on the inner surface, two lines from the margin of the lid. But Ziegler's procedure appeals to me as more desirable.

Treatment of Entropion by Electrolysis.—Everts says: "Introduce a negative needle beneath the integument, parallel to the lid border and three m. a. above the edge: use *5* to *8* m. a. for six to eight minutes. The cicatricial contraction raises the edge of the lid in two weeks. If not, repeat the operation."

Entropion.—Leprince writes, "Cauterization can bring about eversion of the inverted lid in cases of partial entropion. After a cocaine injection, a line of cauterization, is made down to the tarsus.

In cases of partial trichiasis, electrolysis gives excellent results in destroying the bulbs of the hairs. It is inadvisable in total trichiasis, where the object is to replace the lashes and not to destroy them.

Luis Cerera, of Madrid, after cocaine injection, inserts the electrolytic needle horizontally into the eyelid just in front of the tarsus. This is followed by cicatrization and eversion of the lid.

Ectropion.—In Ectropion, Leprince applies the cautery to the conjunctival surface of the lid in the same manner as for entropion. He says that Ziegler's procedure evidently applies to moderate deviations only; as, in extreme cases, plastic operations are always necessary.

BLEPHAROSPASM.

If blepharospasm is not relieved by correction of the refractive error, I treat it with either the sinusoidal current or by the application of the direct current to the lids.

Arcolio says that he employed faradism in a case of intense blepharospasm and obtained a complete recovery in five days, with seances of eight to ten minutes.

A, aged six years, went to Arcolio for treatment July *16*, *07*. He had intermittent blepharospasm in the right eye for one year. He winked five to six times per minute. The current was applied for one minute repeatedly. The next day he winked less frequently. July *27*, no more spasm.

A month later there had been no recurrence.

In hysterical blepharospasm, Leprince prefers the static and the direct currents.

NICTITATION AND PAIN IN THE EYES.

D, aged eight, was brought to me having been afflicted with nictitation for a year. After eight daily applications of three m. a. of positive galvanism to the lids, he recovered.

PARALYSIS OF THE ORBICULARIS.

Leprince advises that, in general, it is best to use galvanism in paralysis of the orbicularis.

A large negative electrode is required, with five to eighteen m. a. of intensity, for five minutes. In any case, one ought not to employ intense galvanic currents, and the seances ought not to exceed fifteen minutes, three times a week.

For the sake of clearness, I will add that with eighteen m. a. of current, the eye electrodes should be three times the usual size.

ECZEMA.

Miss S., aged *37*, consulted me March *3/10*.

She had eczema of both upper lids of six weeks duration. The lids were brownish and scaly. She was treated with the *500* c. p. lamp for twenty minutes tri-weekly.

Four seances produced the desired dermatitis, when treatment was discontinued.

A week later, the lids were perfectly normal.

HERPES OPTHALMICUS.

Leprince says that the galvanic current relieves the pain and accelerates the recovery of this eruption.

In two complicated cases, Page has employed the continuous current with success.

Parasotti has used faradism to restore the sensibility in one case.

In one case, Leprince used the *x*-ray. After four seances, the pain had completely disappeared and recovery followed in ten days.

NEVUS.

Bordier mentions the happy results obtained

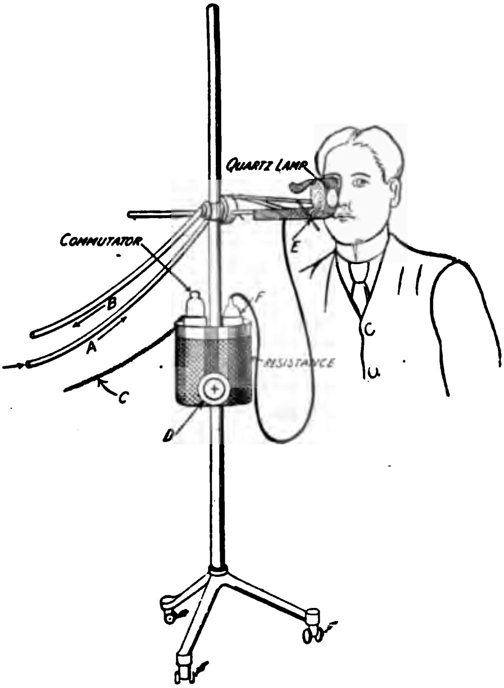


Fig. 95.—Krohmeyer's Lamp.

with a Kromeyer's lamp, applied directly to sections of a very extensive nevus.

The application of intense light was made to each part for a half hour, daily, for fifteen minutes. At the end of five days, the nevus was replaced by a rosy tint and the cicatrice was perfectly smooth.

NEVUS VASCULARIS. ANGIOMA. MOTHER'S MARKS. BIRTH MARKS. BLASTOMYCETES.

Rogers writes that the forms of nevus vascularis which are most amenable to treatment include nevus flammeus: known as birthmark or port wine stain. It is congenital.

Technic.—If the nevus is not more than one to two inches in diameter, it should be covered by pieces of asbestos paper, one-sixteenth of an inch thick, which have been moistened in cold water, and, through which, holes the size of the diseased surface have been made. Adjust six or seven layers around the nevus. The *500* c. p. lamp should be brought within an inch or two of the surface for five or ten seconds to superficially cauterize it. All

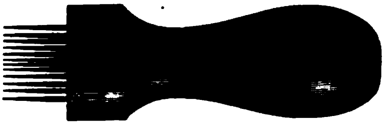


Fig. 96.—Multiple Electrolytic Needle.

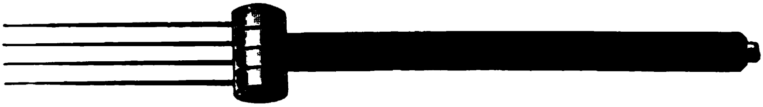


Fig. 97.—Multiple Needle Holder.

smarting ceases upon removal of the lamp. The epidermis only is destroyed, but the blood is coagulated in the smaller vessels. A painless blister results. There will be no cicatrix. If the disease is extensive, an anaesthetic may be given.

Leprince says that it is electrolysis, that is generally employed in nevi, angiomas, etc., though both high-frequency and radium have given unexpectedly favorable results.

Bergonié's method is the simplest and surest. He uses a bi-polar needle, one being attached to the positive pole, the other to the negative. The operator ought to attend only to the needles and constantly observe the field of operation. In general, the periphery of the growth should be attacked, in order to rapidly limit the extension of the growth. When the tumor has been well circumscribed, electropuncture the central parts, commencing always at the salient points.

The intensity of the current should be, perhaps, thirty to fifty m. a. Leprince uses only ten m. a. The time depends upon the condition of the surface tissue. So soon as the skin shows discoloration, the needles must be withdrawn. In stopping the current, it must be gradually reduced to zero.

In angioma, discontinue treatment when, instead of a soft mass, the tumor presents small nodulated superimposed indurations. The effect of this secondary coagulation is comparable with the thrombus of obliterating phlebitis.

In cases of plain angioma, Bergonié has also had marked success in using moderate sparking from Oudin's solenoid,—applying it directly to the surface. The tissue turns white after some seconds of the application.

The dosage must be accurately adjusted to the case, if, after recovery, the tissue involved is to correspond with and resemble that of the surrounding surface.

Blastomycetes.—The best cure for this singular disease of the skin of the eyelids, instances of which have so far been met with almost exclusively in Chicago, appears to be the local application of *x*-rays and massive doses of potassium iodide.

CYST.

The following cases will illustrate my method of procedure in treating cysts.

Mrs. J., aged *54*, consulted me on March *10/08*.

She has had a serous cyst for fourteen years at the edge of the nasal end of the right lower lid, one-quarter to one-half an inch in size. On March *10*, *20*, *25*, and April *2*, the negative needle was introduced into the cyst, with a current of five m. a. for from three to fifteen minutes, and the growth was much reduced in size. On April *9*, a bi-polar needle, with five m. a. was used for five minutes and proved much more effective than the monopolar. The growth disappeared.

Mrs. F. B., aged *40*, came to me March *25/07*.

She has a tarsal cyst of the right upper lid.

℞. X-ray, with low tube, two-inch spark-gap, with patient three inches from the tube, applied for seven minutes every second day. April *26*. The nodule has disappeared.

The above use of the *x*-ray was merely experimental and not to be recommended in practice.

XANTHALASMA.

A. L. B. consulted me April *6/07*.

Xanthalasma had been noticed for six months.

A yellow spot, one-quarter by one-eighth of an inch showed at the inner end of the left upper lid and one opposite one-eighth by one-eighth of an inch on the lower lid.

℞. The negative needle, with two m. a. of current, for five minutes, in the lower, under cocaine injection.

April 10. The negative needle, with one m. a. of current was inserted in the three yellow spots on the left lid.

April 24. There is no trace of discoloration.

Mrs. —, aged 37, consulted me regarding three yellow patches, one-eighth by one-quarter of an inch in size, which had disfigured her lids during four years. Xanthalasma.

Treatment: After cocaine injection, the negative needle, with one m. a. of current gradually increased to five, was inserted under the patch for four minutes; then the needle was inserted for four minutes at right angles to first position. The remaining patches were treated similarly subsequently. No pain. Each patch completely disappeared in two weeks after treatment.

Mrs. —, aged 36, had a patch above and below each inner canthus. One was removed in one sitting, with five m. a. of current, which was turned on rapidly. The pain was so severe that the patient elected to have the remaining patches excised under chloroform.

Caution.—In electrolysis, always turn on the current slowly, increasing to maximum gradually, so as to avoid unnecessary pain.

ACUTE CATARRHAL CONJUNCTIVITIS.

Several of my acute catarrhal conjunctivitis cases, treated by exposure to a 500 c. p. incandescent lamp, recovered in an unusually short period of four or five days;—the first treatment even having afforded marked relief.

Technic.—The patient lies on a couch, with the face protected by a towel or asbestos paper. The eyes, open or closed, are exposed one foot from the lamp, for ten to twenty minutes. When the heat becomes unpleasant, the patient intercepts the light for a few moments with a fan.

The above well illustrates the beneficial effect of the radiant energy of the incandescent lamp in an infectious disease, for, notwithstanding the statement that the supra-violet or actinic rays are filtered out or absorbed by the glass of the globe, a considerable quantity of supra-violet and other actinic rays in the spectrum penetrate the glass;—sufficient to produce bactericidal effects.

A *50* c. p. incandescent lamp, held near the eye, may produce equally good results in conjunctivitis and other superficial diseases.

In case the conjunctivitis is due to the Morax Axenfeld infection, it is better to treat it with the sulphate of zinc solution than by light or by the silver salts.

1. G. T., aged *19*, came to me on March *1/10*, suffering with acute catarrhal conjunctivitis. The patient completely recovered in four days, under the *500* c. p. lamp applied for twenty minutes daily. This is a more rapid recovery than under any drug treatment in my experience.

2. Dr. J. C. McI., aged *52*.

There had been acute catarrhal conjunctivitis of the left eye for two days; ocular and palpebral conjunctiva considerably swelled; moderate purulent discharge.

Incipient conjunctivitis in right eye for one day.

Recovery under four treatments of *500* c. p. lamp, of twenty minutes daily. After the first treatment the eyes were much more comfortable. There was unusual improvement in forty-eight hours. The swelling disappeared after the third treatment.

CHRONIC PALPEBRAL CONJUNCTIVITIS.

1. Mr. S., aged *38*, consulted me in November, *1909*.

He had chronic palpebral conjunctivitis. The palpebral conjunctiva was very red and velvety; the bulbar conjunctiva slightly injected; excessive lachrymation and photophobia. He had had very considerable treatment with collyria of zinc sulphate, etc., without any improvement.

℞. X-ray, with low tube, for eight minutes at four inches, three times a week.

December *4/09*. X-ray flashing, for eight minutes tri-weekly.

March *15/10*. Lids fairly smooth. Lachrymation has ceased and there is very slight photophobia.

Those cases, in which the tissues are nearer to normal than in granular lids, yield much less rapidly and effectually to treatment.

2. A patient of mine, who had for years a chronic hyperplastic conjunctivitis, which very much disturbed her sleep, had been ineffectually treated medically.

Positive galvanism, *3* m. a., with a copper electrode applied to the cocainized palpebral conjunctiva, for five minutes daily resulted in recovery in two weeks.

3. H. P., aged *19*, consulted me in September, *'05*.

He had chronic palpebral conjunctivitis. The eyes had troubled him at times since April *05*. The palpebral conjunctiva of both sides is red, velvety and hypertrophied.

Left eye,—pannus, multiple superficial ulcers and infiltrates in the cornea. Vision of left eye = *3/50*.

There is eczema of the face, scalp and nares.

℞. Ichthyol, two per cent., to be dropped into the eyes three times a day.

May *10*. Peritomy on the left eye.

May *17*. Vision of left eye = *20/100* and the corneal infiltration is much less.

May *24*. Vision of left eye, with + *1.00* = *20/70*.

℞. X-ray exposures, with low tube, at six inches, for ten minutes daily.

June *7*. Vision of left eye = *20/50*.

Kassabian had a patient who suffered with chronic conjunctivitis for seven years and was unsuccessfully treated by two prominent oculists. He recovered with *x*-ray, medium tube, at twelve inches, for one to two minutes, twice weekly for three months,—then tri-weekly.

PHLYCTENULAR CONJUNCTIVITIS.

1. S. McC., aged *8*. A phlyctenular nodule had existed at the corneal margin for three days.

I applied the *500* c. p. lamp, at six inches, for twenty minutes daily. He completely recovered in six days.

2. Josie O. M., aged *15*, consulted me February *4/08*.

Both eyes had been sore at times since an attack of diphtheria five years previously. The left eye had been inflamed since last December. She has had terrible pain during the last week.

Vision of left eye = *15/200*. There are four phlyctenular nodules on the cornea and central opacity.

I performed a peritomy.

Feb. *10*. Cornea clearing. Vision, L. E. = *10/200*.

March *28*. Several corneal ulcers have appeared during the past three weeks, which have been only moderately controlled by the *500* c. p. lamp, used for one half-hour daily.

The eye was exposed to the x-ray for ten minutes tri-weekly.

June *6*. The ulcers healed promptly in three radiations, but relapsed once afterwards.

August *1*. Discontinued the x-ray.

Sept. *18*. Left eye quiet. Vision = *6/200*.

April *12*. Under the use of Bier's cupping glass and dionin, the vision of the eye has improved to *15/100*.

OPHTHALMIA NEONATORUM SUCCESSFULLY TREATED BY ZINC CATAPHORESIS.

Ramsden claims that many cases of corneal opacity can be prevented by treatment with zinc ions. He cites an illustrative case.—The lids were everted and a positive electrode, covered with cotton well saturated with a twenty per cent. solution of sulphate of zinc, was applied with a current of one-half a milliampere for three minutes. Twelve hours later the inflammation was subsiding and another application was made. Two days later the case was cured.

Ramsden thinks that with nitrate of silver or protargol applications, the case would have taken fourteen anxious days.

GONORRHOEAL OPHTHALMIA.

Rogers advises the following treatment,—Cleanse the eye with boric solution. Apply the *500* c. p. lamp for a few seconds to the eye as closely as it can be endured. Interpose the fan, and repeat every few seconds for two to five minutes. Later, in the less acute stage, apply the light at one inch for fifteen minutes, once to twice daily."

Considering that ophthalmia neonatorum is generally due to the same gonococcus as that of gonorrhoeal ophthalmia, the latter would probably yield to the treatment which Ramsden found so successful in ophthalmia neonatorum.

VERNAL CATARRH.

While volumes have been written of late, on the pathology of vernal catarrh, the treatment recommended consists mainly of placebos. Rarely is the success of the *x*-ray treatment mentioned.

D. H., aged *19*, consulted me July *15/09*.

He had had spring catarrh for four years. There is a gelatinous looking elevation at upper margin of cornea. A velvety granular surface at reflex fold of lids. The symptoms are always much aggravated in the summer months.

Previous Treatment.—For two and a half years, he has been treated with nitrate of silver, with some improvement.

A bacteriological examination by Dr. Harrower shows a few pus cells and staphylococci.

Treatment.—X-ray, at intervals, twice weekly, with low tube, at six inches for eight minutes.

July *18/10*. Patient reports, "Eyes perfectly well last winter, and very much better this summer than during any one previously."

Previously to the discovery of the *x*-ray, I treated some cases effectively with the galvano-cautery. I applied the cautery intermittently to small areas of the diseased cirum-corneal and palpebral tissues.

TUBERCULOSIS OF THE PALPEBRAL CONJUNCTIVA.

Sidney Stevenson reports an interesting case as follows,—A little girl of four years, with tubercular conjunctiva. The palpebral conjunctiva and retrotarsal folds were strewn with miliary granulations. Thirteen *x*-ray exposures, of ten minutes each, were given. Recovery followed.

Use of Photo-Therapy in Tuberculosis of the Conjunctiva.—Lundsguard employs photo-therapy exclusively in such cases. In eight cases of secondary conjunctival lupus, he had seven cases of recovery without recurrence in two and a half years. In four primary cases, recovery was complete. In one case only there persisted a thickening of the conjunctiva with trichiasis.

The seances varied from seventeen to twenty-four in number with one induration remaining in each case.

PTERYGIUM TENUIS.

Horace Starkey obtained excellent results with the positive needle in several cases, using *2* m. a. and repeating it. The needle is thrust at right angles under the pterygium, near the cornea and again near the canthus.

I failed, in two cases, to get any improvement, which was probably due to a faulty technic. I would advise, that, where there are visible vessels in the pterygium, an attempt should be made to introduce the needle longitudinally into their whole length; and, also, if any ulceration can be found at the point of the pterygium, to apply the needle over that surface as well, and to use a current sufficient to whiten the growth.

Pensier writes,—"We have found the positive pole, as commended by Starkey, causes a hard scar. The positive electrode is placed on the temple, the negative needle is forced into the cocainized tumor, —then the current of *3* to *4* m. a. is gradually turned on and continued for thirty to ninety seconds. In very large pterygia, I use as much as ten m. a. for two to three minutes. I introduce the needle both horizontally and vertically into the tumor, making a double cauterization in the form of a cross. In small pterygia, one seance of thirty to ninety seconds, with a current of *3* to *4* m. a. is quite sufficient; —then the current of *3* to *4* m. a. is gradually turned forced horizontally into the growth."

Pterygium Treated by Electrolysis in a Novel Manner.—Dr. J. H. Davis, Washington, Ohio, claims that the growth of pterygium can be stopped. He attaches a rat-tooth forceps to the negative pole, catches up the growth and uses from three to five m. a. of current till the vessels turn white. This is repeated in three to four places, and in a week, or ten days, if any of the growth is left, the treatment is repeated.

CHALAZION TREATED BY ELECTROLYSIS.

Alleman, New York, says that the negative needle, with a *3* to *5* m. a. current, for ten minutes, may be used under cocainization, if the patient will not submit to the more ready excision.

If thickening remains after the removal of a chalazion or stye, grasp the part with the forceps and apply to it the negative sponge, with two m. a. of current for two to three minutes.

The negative needle, inserted into the indurated tissues, with a current of *1* to *3* m. a. for five minutes, would, I think, secure the result in a much shorter time.

Pensier has used negative electrolysis with four to six m. a. for chalazion. He has used equally bipolar electrolysis. Recovery requires fifteen days.

It seems logical, he says, to reserve this treatment for small chalazia, in which the removal is difficult and often refused by the patient.

TRACHOMA.

The first published case of trachoma, treated by *x*-ray in America, was reported by me, in the Chicago Elec. Soc. Journal, Jan. *3/03*.

In thirteen cases, I have had only one failure; the others showed such excellent results that I would not now consider other methods of treatment.

My technic is to expose the closed lids daily for two weeks, then tri-weekly, at five inches from a tube excited by a coil current, which will not break down a spark-gap of more than two and a half inches;—the tube being regulated by an automatic regulator at three inches from the cathode. Because the eye is less sensitive to the rays than is the skin, the latter is left without a shield, that it may serve as an indicator and prevent excessive treatment. Should itching, burning, tanning or epilation occur, or, should vision be found, by daily testing, to be reduced, further treatment must, for a time, be discontinued, until the symptoms disappear. The number of treatments required is generally from twenty-five to thirty-five.

For two years past, I have used the intermittent flashing, recommended by Dr. Finley R. Cook, with ten minute exposures, but cannot say whether the results are better. Possibly, burning is less likely to occur; but, that it may occur, contrary to the statement of Dr. Cook, I am assured by a confrère.

Case *1*. L. G. Greek, aged *45*, has had symptoms of granular lids for many years. Moderate sized, discrete granules line the upper tarsus and fornix. The lower lids are less involved. Bulbar conjunctiva very red.

Vision R. E. = *6/20*. L. E. (divergent) = *4/50*.

℞. X-ray, medium tube, at six inches, for ten minutes tri-weekly. The lids were everted by forceps.

March *24*.—There is a mild dermatitis of the right lids. The lids are much smoother and the bulbar conjunctiva is less vascular. There is an ulcer of the right cornea. (From raying, or trachoma?) Raying discontinued.

April *9*.—The lids are perfectly smooth and the ulcer is healed.

This case illustrates the advisability of intermitting treatment, as Mayou suggests; since, after the raying was discontinued, recovery progressed.

Twenty exposures, in all, had been made.

In *1912*, there had been no relapse, and the condition was more ideal than in any case of recovery I had seen.

Case *2*.—Dr. G., aged *54*. May *12*, *1903*. Both eyes were inflamed; the right frequently since, the left not until two years ago. I have applied, at intervals during the past two years,—Nargol, twenty per cent; Ung. Hydrarg. Oxide Rub., and massage, with little benefit and he has suffered very much.

Present State.—The right eye has granulations of moderate size on both lids. The left eye is similar to the right.

℞. X-ray medium tube at six inches for ten minutes bi-weekly. Recovery in two months, with less than sixteen seances.

October *13*, *1906*. There has been a relapse in the right eye during the past week. Acute trachoma, pannus and corneal ulcer. ℞. Medium tube at six inches, for eight minutes, tri-weekly, with the lids closed and the face unprotected.

December *31*.—Has had twenty exposures. The lids are smooth; there is no pannus or ulcer and he reads comfortably, which he had not done for many years.

There has been no relapse up to May, *1912*.

Case *3*.—G. D., aged *13*. March *22*, *1904*. Moderate trachoma of both eyes; the patient has had symptoms for two and a half years. Vision R. or L. = *20/30*.

℞. X-ray twice weekly, with a high tube, at six inches for ten minutes.

After thirty radiations, the lids are smooth, without any visible cicatrization, and vision is normal in each eye.

Case *4*.—M. D. P., aged *29*. April *5*, *1907*.

The left eye had been very red and sore for three years.

Present State.—The bulbar conjunctiva is very red and swollen; the upper lid is thickly studded with granulations. The lower lid presents less markedly prominent granulations. There are—a double ulceration of the cornea, pannus tenuis, extreme photophobia and considerable pain.

℞. X-ray with *2*-inch spark gap. Patient at four inches from the tube, for seven minutes daily.

April *7*.—There is severe circumorbital pain. ℞.—Aspirin grs. *15* every three hours.

April *8*.—No pain.

May *6*.—Vision L. E. = *20/25*. ℞. Violet light from *50* c. p. lamp every second day, alternating with the *x*-ray

May *21*.—Vision normal and lids smooth.

The patient had twenty-five daily *x*-ray treatments and six tri-weekly.

Case *5*.—A. G., aged *8*. February *24/03*. The patient has had weak eyes for five years. Both upper lids are markedly granular. Corneae:—the upper half opaque. Vision R. or L. = *6/20*. He was treated during *1901-2* by two oculists, with some improvement.

℞. X-ray tri-weekly.

June *6*. The patient has attended very irregularly, having received only fifteen treatments. Vision has increased and the granulations are much less prominent. With further treatment, there is little doubt that complete recovery would have resulted.

In one case of doubtful trachoma, unilateral, the patient—a physician—objected to a continuance of the raying, and recovered under the use of the *500* c. p. incandescent lamp.

A host of workers, Stevenson, Walsh, Vassutinsky, Geyser, Hoeniker, Romanen, Ayres, etc., report uniform success with the *x*-ray; while Jackson, Fox, Suker, deSchweinitz and Sweet think that the older methods are equally satisfactory or preferable.

C. E. Rogers,—"during the most acute stage," applies the rays from the *500* c. p. lamp, sharply and for short periods, four or five times at a sitting, once or twice daily. At a later period, the treatments may require from *15* to *20* minutes once or twice daily." The safety of the lamp may recommend it to those who are unfamiliar with the use of the *x*-ray.

Stevenson and Walsh treated one case with a high-frequency current, applied to the conjunctiva. After twenty-three applications, with a vulcanite electrode connected with a d'Arsonval resonator, the disease disappeared, that,—in their words,—would have lingered two or three years with ordinary treatment.

Seven cases, treated by N. Bishop, of London, with the high-frequency current did not improve.

Myers makes three to four punctures in each granule, with the negative needle, using one half to two m. a. of direct current, with cocaine anaesthesia. He has made *20* to *30* punctures at a sitting and has treated hundreds of cases so satisfactorily, that he has abandoned the use of copper and silver.

Rodolfi applies a negative galvanic copper electrode to the conjunctiva of the everted lids, with very satisfactory results.

Some fifteen years since, both Neiswanger and I applied to the granular surface a current of three to five m. a. for five minutes daily, with the *positive* copper electrode to secure cataphoresis. I inserted the electrode under the uneverted lids to the sulci, and moved the electrode from end to end of the lids, withdrawing them gently from the cornea. The results were more satisfactory than had been secured with drugs. Since *1903*, I have preferred the use of the *x*-ray.

G. Lindsay Johnson, of London, applies thirty to fifty m. a. of a direct current, with electrolytic blades in the furrows of deep parallel incisions. I would prefer ten to fifteen m. a. in order to avoid the cauterizing effect of fifty m. a.

M. S. Mayou, of London, is, out of a wide experience, so enthusiastic an advocate of the treatment of trachoma by *x*-ray, that we will let him speak for himself:—

In trachoma, he says, we have a disease that is very closely allied to lupus. In *x*-rays, we have a method of setting up a leucocytosis with the minimum of destruction to epithelial and other tissues, and, further, we have a means of producing an inflammation, from a mild leucocytosis to a gangrene of the part, which, with due care, and experience, we have under almost perfect control. The leucocytosis is much more prolonged than that in any method previously adopted, and the destruction is not nearly so great.

Operations can be followed by *x*-rays to complete the work in preference to one of the other irritants now in use. Operation should never follow *x*-ray treatment without considerable interval.

At the beginning of the year, I presented the first case treated by *x*-ray. I have now discarded the mask, as I never expose the patient sufficiently to get any reaction at all in the skin. The upper lid is everted, and the lower lid pushed up so as to cover as much of the cornea as possible; but in bad cases, with pannus, the cornea is left exposed. I have never had any trouble with the globe following *x*-ray treatment.

The patient is seated about nine inches from the anode, with a moderately soft tube and a current of six amperes. A two minutes exposure is given for four to six successive days. If there be much injection, or the case be an acute one, four days are usually sufficient. A week's rest is then given, and, if no reaction is set up the patient is exposed twice a week, until there is a slight increase in the photophobia, which shows that he is beginning to react. About this time, the granules begin to disappear. Exposures, once, twice or three times a week are made, until they disappear entirely, when all treatment must be stopped, as it requires some weeks for the infiltration set up by the *x*-ray to settle down; and it is difficult to tell whether the disease is eradicated. A supple, non-contracted non-scarred conjunctiva is finally produced. The pannus often clears with great rapidity. Even dense corneal opacity will often clear considerably.

In one case, in which the patient could only see shadows, she could, in two months, count fingers three feet away. Sometimes the granules begin to disappear from almost the first exposure; again, other cases require eight to ten treatments before showing signs of reaction.

With regard to the cases, the most satisfactory are the chronic; and the earlier they seek treatment the more rapid and satisfactory will be the result. Chronic cases will allow of more frequent exposure; acute, diffuse infiltrations, with thickening of the lid and much photophobia, requiring more careful exposure, extending over a much longer period. Old, chronic cases, in which the lid trouble has almost disappeared, but, in which there is much opacity of the cornea, will, after the first reaction—which should be mild—often improve considerably under exposures at long intervals.

The chief advantages of this treatment are:

1. There is considerably less deformity in the lid after treatment than when other means are employed.
2. It is practically painless.
3. The pannus clears more thoroughly.

Morton, of New York, has treated trachoma very successfully, by what he designates *cupric cataphoresis* or electric medicament diffusion. I quote the following,—

1. In *1892.* Aged *50.* There is a corneal vascularity; trachomatous bodies, vision impaired. I cocainized the conjunctiva, then a copper electrode was passed over the everted lids, with two m. a. of current. The cornea cleared, the trachoma reduced, vision improved.

Morton considers that copper and zinc are the best electrodes.

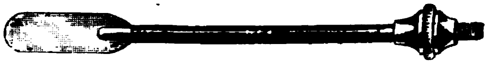


Fig. 98.—Copper Eye Electrode.

2. Aged *12, 1893.* Acute trachoma.

A copper electrode with *2* m. a. of current was applied to each lid for one minute. There were six applications, resulting in recovery. No relapse within a year.

3. July *21/93.* Age *21.* Second stage of trachoma. Extensive corneal ulcers.

A copper electrode was applied, with *3* m. a. of current.

July *24.* Ten m. a. for two to three minutes.

July *26.* Repeat.

July *31.* Cornea perfectly clear. Recovery after six more treatments.

4. In */93.* Aged *8.* Second stage of trachoma. Purulent conjunctivitis. Cocainized the conjunctiva, five treatments with seven m. a. were given, followed by recovery.

5. In */93.* Trachoma of seven months duration, in lad of *16.* Twelve treatments with three m. a., effected a complete cure.

6. January *15/94.* An Egyptian, aged *17.* Trachoma of five years standing or more. Constant muco-purulent discharge. Vision smoky. Cicatricial conjunctivitis.

℞. Positive zinc electrode to conjunctiva of both eyes, with a current of *3* m. a. repeatedly until March *23*, when the patient sees clearly, and there is no mucous discharge.

April *18.* The patient regards herself as well.

7. March *23/94.* Aged *11.* First stage of trachoma.

A copper electrode was used with *1* m. a. of current until March *28*, when three m. a. were prescribed.

April *13.* Cured.

8. A case of eleven years standing, trachoma, copper electrodes, with one to three m. a. of current, cured the patient in four weeks.

Leprince, writing of trachoma and follicular conjunctivitis, says,—"These two diseases were first treated by electrolysis and galvano-cauterization, but, while the results were appreciable in follicular conjunctivitis, there was no pronounced success in trachoma.

Nevertheless, electrolysis, with a curved flat electrode, has given good results in the hands of Dr. A. Dickson of Mobile, Alaska, who has treated, in this way twenty-five cases of trachoma. In the first case, he made one application only, for eight minutes, with fifteen m. a. of current, at the end of which time, a gray deposit appeared upon the conjunctival surface of the cornea. The second eye was treated in the same manner seven months later. The cornea cleared and vision returned to normal. Dickson advises a current of three to five or even eight milliamperes.

Since the advent of photo-therapy, many have treated trachoma with light, to the exclusion of any other mode of treatment."

Dr. A. C. Geyser treated successfully eighteen cases of granular lids by the *x*-ray and the high-frequency vacuum electrodes combined. His technic is as follows,—*x*-ray for three to five minutes at six inches on alternate days for two weeks. After six to eight exposures to the *x*-ray, the high-frequency tube is brought in direct contact with the entire conjunctiva and is moved to and fro during one to three minutes. Then a broad electrode is applied to the outer surface of the lid.

The vacuum tube treatment should be continued for from one to three weeks.

A patient, aged *43*, had trachoma of the left side only, for eight years. The cornea was cloudy. Eight *x*-ray exposures were given. The high-frequency tube was then used, for the balance of the two months, when the vision was almost as good as in the right eye. The patient was cured and continued so after six months.

Darier, Bettremieux, Goldzicher, and Mayou have used radiotherapy with success in the treatment of trachoma and follicular conjunctivitis. Some close the lids and others leave them open.

Follicular conjunctivitis, which is generally limited to the lower sulcus and does not involve the cornea usually recovers in from two to three weeks after one treatment by expression with the roller forceps,—hence it does not seem advisable to spend the time required in treating it with the *x*-ray, or other electrical means.

Reich and Burchardt employed, with success, the galvano-cautery, applying it to the follicles and securing good results in eleven cases.

Wicherkiweicz finds this method painful and prefers expression.

Trachoma Treated With Photo-Therapy.—Hegner and Baum have been gratified with the favorable results they obtained in the treatment of granular conjunctivitis with luminous rays traversing a block of quartz. They localize the action of the radiation upon the granular points. Without the interposition of the quartz, they claim it would be necessary to treat at a considerable distance from the retina.

Recovery required from fourteen to twenty-nine irradiations.

LACHRYMAL GLAND.

C. McG., aged *39*, consulted me October *12/06*.

He has an enlarged ocular lobe of the left lachrymal gland, which has been noticeable for three months.

℞. The negative needle for three minutes in the gland, with one m. a. of current.

Oct. *16*. Repeated, with two m. a. for ten minutes.

November *22*. The gland is much smaller.

EPIPHORA.

In simple cases, look carefully for a source of reflex irritation, especially in the nose.

February *19/07*. J. W. C., aged *70*, consulted me.

For two months past, he has had to mop his eyes frequently with a handkerchief while out of doors; the left eye being the more troublesome. He has epiphora, (lachrymal tears). The lower punctum of the left eye appears small.

Treatment.—The lower canaliculus was probed tri-weekly till March *5*, with very little relief.

For fifty years past, the nose has been running as if he had hay fever. The left turbinate is hypertrophied and very sensitive to the application of a probe.

I treated this turbinate by applying to it a copper positive electrode, wound with cotton, moistened with cocaine and adrenalin, with five m. a. of current, for five minutes daily. After six treatments, the epiphora nearly ceased and the patient discontinued treatment.

April *13/08*. No trace of epiphora since the treatment.

Eighteen months later, the patient reported that he had had no trace of tearing since he discontinued treatment.

Cauterization of the canaliculi of the gland has given Bettremieux good results in cases of intractable lachrymation. Before cocainization, the upper lid is reversed, and the patient is told to look down, and, on the surface of the gland, a certain number of superficial punctures are made. The cauterizations have to be renewed at some days' interval.

Bettremieux thinks that a certain number of the canaliculi are obliterated, and, secondly, that the treatment produces a certain atrophy of the gland.

THE LACHRYMAL PASSAGES.

Stricture.—Electricity was first employed in the treatment of stricture of the lachrymal passages by Desmarre and Tripier in *1863*; later, it was used by Roy in *1875*, Stevenson and Jessup in *1887*, Gorecki in *1889*, Rohmer in *1891* and Gradle in *1893*.

Lagrange improved the method considerably by the use of insulated sounds, in regulating the force of the current, and demonstrating that the current should be increased and diminished progressively. Dor, DuGourly and Fage popularized the method.

Electrolysis acts by the decomposition of the tissues and its microbicidal action was demonstrated by d'Arsonval and Bouasse. Leprince offers the following technic,—An electrical sound, he writes, has its upper half well insulated, still we employ as well Bowman's sounds in silver or red copper. The former are preferable in ordinary cases where a weak current suffices. When it is necessary to exceed five m. a. of current, the copper sound is preferable, because it heats less with the same current and the sound is less apt to induce a stricture. To protect the healthy mucous membrane, an insulated sound is used.

A sound, No. *1* or *2*, is introduced into the lachrymal passages and connected with the negative pole; while the positive pole is placed on the face or in the hand. The current is gradually increased to to five m. a., rarely more. The positive should be immobile, so as not to brusquely vary the intensity of the current. The current should be gradually diminished. The duration should not exceed five minutes.

After the séances, we lavage the lachrymal passages. Treatments should be given every eight days. The first soundings should be made with the largest size of Bowman which will pass. Eight days later, we pass the same or a lower number. After one, two, three, rarely four séances, the canal is sufficiently dilated.

In the case of dacryocystitis, the non-insulated part of the sound is placed in the lachrymal sac. If the dacryocystitis is intense, we catheterize between the electrical treatments and lavage with sublimate, *1* to *5000*.

In positive electrolysis, the technic is the same but we employ the positive electrode and a silver sound. The current is *4* m. a. for two to four minutes. Before the sound is withdrawn, the current is reversed and *2* m. a. passed, which permits the easy removal of the sound without risk of its adhering to the mucous membrane.

The advantage of the ionization is to give to the whole canal an antiseptic, a trophic, and a mechanical action. Leprince says that in a year, he has treated eight cases of dacryocystitis, and of these, seven have been radically relieved by this procedure.

Dr. L. L. Mial, of New York, has found silver the best metal to use in lachrymal stricture.

He says that as a stricture is never the whole length of the canal, it is a matter of much importance to apply the current to the narrowed portion only. Each seance should last from thirty seconds to three minutes. Mial claims that electrolysis is much less painful than the usual way of passing the probe and that it dissolves and relaxes strictures much better than any other method.

Jessup and Stevenson report ten cases of obstruction of the lachrymal punctum or canaliculus treated by electrolysis. They use a curved platinum negative probe with two to four m. a. for thirty seconds. Two or three sittings cure the obstruction permanently.

Peschel has devised a sound presenting on one of its lateral surfaces and near its extremity a small handle. The sound has a diameter of five m. m. and is of service in a certain number of cases with chronic suppuration. As the whole sound is heated, we maintain contact only a second. Peschel has used this sound since *1894*, with success.

DACRYOCYSTOBLENORRHEA.

I cite the following case as an illustration of my method of procedure in this disease.

A boy, who had been treated by probing for months, and, from whose sac, when pressed, pus still poured over the cheek, half a dozen times a day; and whom I probed with Theobold's large sized probes for three weeks without benefit, was completely relieved of any trace of pus after a negative galvanic electrode was applied to the inserted probe for five minutes daily for two weeks, with a current of two m. a.

I have tried cupric cataphoresis, with a positive copper probe, with two to three m. a., but the bleeding it occasioned, in spite of the reversal of the current before withdrawing the probe, induced me to return to the use of the negative electrode.

DACRYOCYSTITIS.

DeWecker, in *1864*, obliterated the sac and lachrymal passage with the galvano-cautery.

In Blenorrhoea of the sac, it has been very much a custom in Europe to excise the sac,—an operation that seems to be much less in favor in America.

The treatment of these cases by probing,—except for the temporary relief which it gives—is a very unsatisfactory procedure. Electrolysis shortens very much the treatment required.

Darier writes that negative galvanism, with a current of four to six m. a. applied by a sponge electrode to the lacrymal probe, for five to six minutes gives more dilation and a speedier cessation of the suppuration than any other treatment.

LACHRYMAL FISTULA.

Leprince treats this disease with the galvano-cautery. He introduces into the lachrymal passage a Bowman's sound to stretch the wall of the sac and then introduces the platinum filament into the fistula until it strikes the sound. Cicatrization is complete in fifteen days. In general, one cauterization is sufficient though a second may sometimes be necessary.

Gil Banos has employed post-operative fulguration, with small sparks, in cases of suppurative dacryocystitis. Four cases treated recovered perfectly in twelve to fourteen days.

CHAPTER II.

CORNEA AND SCLERA.

DISEASES OF THE CORNEA.

Pannus.—Leprince says, "Peritomy by the thermo or galvano-cautery demands very careful management, hence it is difficult to obtain useful effects. To avoid the unfortunate consequences of cauterization, Van Lint recommends electrolytic peritomy. The electrode consists of a sphere two m. m. in diameter upon a little curved stem. The electrode is attached to the negative pole, with two m. a. of current for ten to fifteen minutes and is applied to the whole circumference of the cornea. Lymphatic pannus recovers completely with electrolytic peritomy.

In trachomatous pannus, the results are less brilliant.

Van Lint electrolyzes the lymphatic ulcers of the cornea, which recover in a few days.

Sulzer gives the results in eight cases, showing an average of a little more than *100* per cent of improvement in vision."

Ziegler, by burning a small groove at the sclero-cornea with a galvano-cautery, has often made a peritomy with successful results.

Chrostak had admirable results by galvanization of the sympathetic.

Battesti reports several cases of granular pannus treated successfully with igneous peritomy. The galvano-cautery is easily applied.

KERATITIS PARENCHYMATOSA.

Brière, in *1871*, relates a case of a lad of *13*, attacked in both eyes with keratitis parenchymatosa; diffuse; moderate pain; extreme photophobia; has Hutchinson's teeth.

He had had heat, atropine and mercurial inunctions, etc., for a month without result. Then electricity, five to seven m. a. of current, was applied to each eye and recovery followed in three weeks.

Arcolio treated twenty-two cases, of which fourteen were cured and eight improved. The fourteen were treated by faradism. To institute a comparison, three eyes attacked with the same disease were treated with the continuous current for two months without any result.

Haltenhoff, in analyzing the cases, observes, that one was complicated with hypopion, adding that he does not accept without reserve the experiences of Arcolio.

Pensier has treated several cases of keratitis parenchymatosa with the constant current, two to three m. a. and always obtained good results after forty to fifty seances. I cite two of these cases.

1. December, */93.* —, aged *26.* Under treatment in hospital, seven weeks, for keratitis parenchymatosa. On entering, his vision was almost nil. On leaving, it was *2/40.*

May *16.* Right and left cornea opaque. Pupil very irregular under atropine. Continuous current with atropine, thirty seances, vision *3/15.* Eighteen more treatments, when vision in left eye was *4/7.* Cornea transparent.

2. G., *39.* Right eye affected. Drug treatment ineffective. Then, electricity with two to three m. a. and atropine for twenty seances: only slight improvement, vision remaining *2/30*; thirty more treatments leave the cornea transparent, iris normal, vision *5/10*.

In a personal communication, J. G. Huizinga, writes, "In parenchymatous keratitis, I have used the high-frequency vacuum electrode to the lids, with immediate improvement, after failure by the usual methods.

Arcolio also obtained good results by application of the negative galvanic brush to the conjunctiva for five to eight minutes.

Rogers thinks that the requirements of the case are more properly and satisfactorily met by the *500* c. p. lamp than by any agent heretofore employed, especially during and after the subsidence of the most active stage.

Hereditary Syphilitic Keratitis.—Wirtz reported three cases which were cured by iodine ionization.

Leprince considers iodine ionization a true specific in heriditary syphilitic keratitis. The treatment consists in the application to the eye of a one per cent solution of potassium iodide on the negative electrode.

Leprince adds that in all cases treated with radiotherapy resolution occurred. Photophobia was relieved after each application and the duration of the affection was considerably abridged.

Interstitial Vascular Keratitis.—Improvement is rapid with effluve but complete recovery is slow. It is necessary to produce effluve on all the bulbar conjunctiva.

HYPOPION KERATITIS.

Weisflog reports five recoveries in this disease by the use of faradization, with a large sponge electrode on the closed lids, with one half-hour sittings daily for six to eight times.

While use of the galvano-cautery is followed by little reaction and seems to be the favorite in Europe, I, personally, prefer the Saemisch incision which has given me more recoveries with less opacity.

The *500* c. p. lamp has also given very satisfactory results.

NEURO-PARALYTIC KERATITIS.

In neuro-paralytic keratitis, due to paresis of the left trigeminus, Erb observed decided benefit from the use of galvanism.

Parasotti reports good results with the direct current in one case of interstitial trophic lesion.

TUBERCULAR KERATITIS.

J. G. Huizinga, in a P. C. says: "A case which, under the care of several men, had not been influenced, was, under my application of the *x*-ray, followed, in two months, by complete recovery."

XEROTIC KERATITIS.

Rogers states that he has reports from two cases in which the *500* c. p. lamp was applied locally and generally with very gratifying success.

TUBERCULAR KERATITIS.

Miss X., aged *31*, consulted me April *6/09*.

She has double keratitis,—tubercular.

History,—A year ago last January, her sight suddenly failed for a minute so that she could not see anything; and objects, after that, were misty all day. The left eye cleared perfectly but the right remained misty. The left eye began to get misty last autumn and has steadily become worse.

R. Eye,—The cornea was noticed last July to be hazy, and is now like ground glass. Dr. Curtis, of Eau Claire, Wisconsin, who referred the case to me, noticed that the left cornea was becoming hazy last October and it now has a ground glass appearance.

Previous Treatment,—Last October, she consulted Dr. Curtis, who prescribed dionin, three times a day. Before treatment, the cornea was so opaque that the iris could not be seen. Now the iris is well seen and vision is much improved; but the opacity of the left cornea has increased.

Present State,—General health,—The right hip and thigh have been operated on on account of tuberculosis. Everything fatigues her. She is very nervous. When suddenly spoken to, she goes blind at once. Her sight varies very much during the day; when hungry, or when she lies down.

Vision R. E. = *6/200.* L. E. = *15/50.*

℞. Dionin, *10* per cent. solution, daily; and, in powder, every second evening. Also, the high-frequency condensation couch for fifteen minutes daily.

July *19/10.* Vision has become worse under dionin.

R. E. *6/200.* L. E. = fingers at six inches.

Both corneae have a ground glass appearance, as in keratitis of heriditary syphilis; both sclera are of a dull slate color.

℞. Subconjunctival injections of sodium saccharate *5* per cent. in right eye.

August *6/10.* R. E. = *15/200.* L. E. = fingers at fifteen inches.

August *15*, returns home.

October *28.* Has returned from her vacation; R. E. = *20/200.* L. E. = *3/200.*

℞. Intermittent *x*-ray flashing for ten minutes, daily, with medium tube at six inches.

November *9.* R. E. *20/100.* L. E. = *8/200.*

Nov. *28/10.* Irido cyclitis and line of hypopion in right eye, with severe pain.

℞. *500* c. p. lamp to eye for fifteen minutes. Atropine. An hour later there was no trace of hypopion.

Nov. 29. No pain. A trace of hypopion. Repeat 500 c. p. lamp daily. This reduced the hypopion one-half.

Dec. 12. Eye is quiet. Vision R. E. = 20/50. L. E. = 10/100.

February 2/11. Von Pirquet tuberculin test positive.

Feb. 13. ℞. Tuberculin T. R. (dilute) injection.

May 10/12. Has had tuberculin injections once weekly, and of late, *x*-ray flashes for five minutes tri-weekly.

Vision R. E. = 20/66. L. E. = 20/66.

Discontinued treatment.

CHRONIC SUPPURATIVE DACRYOCYSTITIS.

Dr. H. S. Gradle, of Chicago, in a personal communication says that he introduces as large a Bowman probe as possible and connects this with the negative pole of the direct current of such strength as is easily borne by the tip of the tongue.

The current is applied for two minutes bi- to tri-weekly, and is followed by flushing of the tear passage. He is convinced there is a more rapid recovery than by the stereotyped probing and syringing. The average time required is about six weeks.

He thinks that, under no circumstances is the chemical cautery effective, nor are the results so satisfying.

ULCERATION OF THE CORNEA.

Mrs. J. W., aged 49, consulted me April 30/10.

She has a double phlyctenular keratitis.

Pain has kept her awake most of the night for two weeks. Photophobia is so intense that the eyes can scarcely be examined. There is intense conjunctival injection and corneal opacity.

℞. The 500 c. p. lamp for twenty minutes daily,—at first at two feet, then later the distance gradually diminished, to six inches.

After two weeks the eyes were quiet but the cornea remained opaque. She discontinued treatment.

Traquaire, of Edinburg, states that he has treated the nodule with a fine galvano-cautery point, which he applies cold and then turns on the current.

INDOLENT ULCERS AND FISTULAE OF THE CORNEA.

F. Cornwall writes that in the last fifteen years he has treated all his cases of corneal ulcer, except phlyctenular, with electrolysis and has been gratified in almost every one.

A few cases of fistula, near the corneal margin, were also treated successfully. The needle was made to erode the anterior surface of the iris and the posterior surface of the cornea to induce adhesions.

In indolent ulcers, a very finely pointed needle is selected, a good light and a strong lens. The operator should touch the different points of the ulcer with the point of the needle. A moderate development of air cells should form with *1/2* m. a., but the needle oscillates and must be used with great care.

Dr. Clark W. Hawley of Chicago, reports in a personal communication, three interesting cases of corneal ulcer:

Case *1*. Traumatic Ulcer of the Cornea.

Mr. C. A piece of wheat stalk flew into the left eye, injured the cornea and was removed in the field. A severe corneal ulcer resulted, of three m. m. in diameter. It had been under treatment for some time, without improvement. I immediately cauterized it over its entire surface with many small dots, using the electric cautery. This retarded the spread of the ulcer, as I was very thorough at the border. Still it did not seem to do well and I repeated the operation, going much deeper with my point, when it rapidly went on to complete healing.

Result: A very extensive infiltration, with vision less than *6/60*.

Under the continued use of increasing doses of dionin for many months, the vision rose to *6/18*.

The patient, later, reported the distant vision good and he was able to read coarse newspaper print.

Case *2*. Mrs. C. Injured in right eye by a piece of iron near the centre of the cornea, resulting in severe ulcer of about *2-1/2* m. m. in size. Treated for a few days with atropin and antiseptics, without improvement.

The electric cautery was then used, going over the entire ulcer, making a continuous chain of dots at the margin. It then healed slowly. The patient was put on dionin, which was rapidly causing the disappearance of the infiltration. When last seen vision was *6/24*.

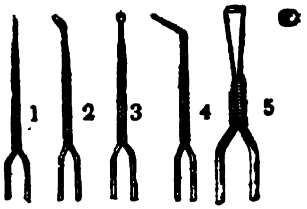


Fig. 99.—Eye Cautery Electrodes.

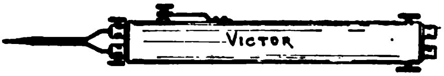


Fig. 100.—Eye Cautery Electrode Handle.

Case *3*. Mr. D. Entered hospital with a corneal ulcer occupying the outer lower third of the cornea of the right eye, and spreading very rapidly into the deep tissue. A culture was made which showed bacillus pyocyaneus. The electric cautery was applied very thoroughly but it did not stop the process, and the course was so rapid that on the fourth day the eye was removed: panophthalmitis having rapidly developed.

This bacillus is very destructive and rarely is seen in eye pathology.

ULCERATIVE KERATITIS.

Arcolio has treated thirty cases of this disease, in twenty of which there was hypopion. He attached the negative pole to the forceps and applied it to the eye. This produced absorption of the pus and favored healing of the ulcer.

Nieden asserts the superiority of the galvanic cautery in ulcers of the cornea. In one hundred cases, which he treated with the galvanic cautery, eighty-three were severe. There were rodent ulcers with sixty-eight per cent. hypopion. In eighty-two cases, one cauterization sufficed. In twelve repetition was necessary. In six, the cautery was used three to six times. The ciliary pain rapidly disappeared.

He says: "Recovery occurs in one-half the time required by any other method and with less opacity of the cornea."

Macula persisted in ninety-three. There were seven leucomas. No eye has been lost with phthisis. Duration of treatment was usually about thirteen days.

Ulceration of the Cornea Treated With Zinc Ionization, or (as it is more usually designated)—Zinc Cataphoresis.—Wirtz has treated by ionization thirty eight patients. I cite two of his cases.

W. M., aged *41*. Affected for eight days. Has ulceration of the cornea. The pupil is imperfectly dilatable by atropine. Vision = *0.1*. Diplobacillus of Petit. Hypopion. Treatment by zinc ionization, one-half per cent., with the positive pole to the eye, with *2* m. a. of current for two minutes. Cessation of pain in one hour. The next day, the hypopion had disappeared. Four days later, the ulcer was healed and the viscion was *6/18*.

H. S. Had an ulcer following extraction of a foreign body. Vision = *6/36*. There are abundant pneumococci.

Treatment by zinc ionization during one minute. Intense pain for an hour, then cessation. In ten days, vision = *6/10*.

Traquairė, of Edinburg, states that he has obtained better results in a score of analagous cases with ionization than with cauterization, and has secured better visual results.

Zahn finds zinc ionization equally efficacious in diplobacillus and dentritic ulcers and in ulcerative blepharitis.

Corneal Ulcers Treated With Photo-Therapy and Radio-Therapy.—Hertel, in the clinic of Prof. Wagenmann, found by experimenting with phototherapy and Saemisch incision, that the action of the former arrested the progress of the ulcer which the latter had not influenced.

Leprince, with an experience of thirteen cases, concludes that cauterization is not superior to phototherapy in serious cases.

Corneal Ulcers Treated With Intermittent X-rays.—Coover cites four cases of corneal ulcer treated by intermittent *x*-rays,—

1. January *4/09*. *8*, aged *37*. Has traumatic ulcer of four-fifths of the cornea, with light perception only. The patient was treated on Jan. *4*, *6*, *7*, *8*, *9*, *11*, *15*, *20*, *22*. After each irradiation, there was slight congestion of the eye. The ulcer diminished in size and vision promptly improved. The last treatment was on February *4*. The ulcer was entirely healed and the infiltration of the cornea nearly absorbed.

2. February *18.* —, aged *60.* Right eye has been inflamed for a month. The cornea is nebulous with central dentritic ulcer and contracted pupil. Treated with atropine.

Feb. *19.* Pupil dilated. ℞. Intermittent *x*-rays.

At the end of ten treatments, the ulcer is completely healed with slight opacity remaining.

3. January *7/09.* —, aged *23.* For six months, the left eye has been inflamed. A paracentral ulcer of the right eye and a central ulcer of the left eye. The eyes were treated with holocaine and atropine until February *15,* without any improvement. Then *x*-ray treatment was begun, and after the second seance the ulceration was ameliorrated. The treatment was continued, at intervals, during three weeks and the ulcers were healed. While no general or local treatment was given, the general health improved.

4. February *22/09.* T. C., aged *72.* Patient had a small traumatic ulcer with hypopion. Diplococci.

After one treatment with the intermittent *x*-rays, the hypopion disappeared, and healing of the ulcer followed in six treatments.

Leprince states that he has used intermittent *x*-rays in three cases of strumous kerato-conjunctivitis with ulceration in children aged eight and eleven years. In three seances, the photophobia disappeared and the ulcers healed.

Arcolio reports good results by touching the ulcer two or three times with the negative galvanic brush during each sitting.

Dennett says that corneal ulcers heal rapidly by the *x*-ray.

Dr. E. F. Snydacher, of Chicago, in a personal communication, says: "In cauterizing ulcers of the cornea, I have for some years employed the 95 per cent. carbolic acid. I believe that the slough following its use is less severe than that following the actual cautery. Furthermore, as the carbolic acid permeates the surrounding tissues to a certain extent, I believe we get a more diffuse antiseptic action than that following the actual cautery."

Dr. Heman H. Brown,of Chicago, in P. C. says,—In certain forms of corneal affection, I have more confidence in the use of the actual cautery than in any other agent. For many years, I have used the cautery in stubborn, unclean, superficial ulcers, applying a fairly sharp point, under cocaine anesthesia, to surround the ulcer with a furrow rather than attempt to touch all the affected tissue. This obviates destruction of transparent tissue.

When large areas are involved, as in serpigenous ulcers, etc., it is usually possible to surround only the attacking points, which are discernible by the deeper infiltrate, with little destruction of tissue, although, later, it may be necessary to give similar attention to other points.

I believe we have in the cautery an ideal agent for the treatment of senile superficial corneal ulcers. I know of no means by which we can so suddenly check the fasicular vascular ulcer, and with so little temporary and permanent injury of the cornea.

A simple crescent furrow in the clear cornea around the advancing point is sufficient.

In recurrent hypopion, from deep ulceration, I have been able to stop the process with rapid absorption of pus and recovery of the eye, with a surprisingly small area of opacity.

Treatment of Corneal Ulcer With the 500 C. P. Lamp.—Rogers cites the following case,—

—, aged *34*. Six years previously, under Dr. Brunson's care, the patient had had trachoma.

At present the conjunctiva is granular and acutely inflamed. There is a large inflamed ulcer of the cornea. Dr. B. considered the advisability of removing the eye.

Treatment,—The *500* c. p. lamp was applied for one minute. Afterwards, for ten to twenty minutes daily, for seventeen days. The patient was discharged cured.

RELAPSING ULCERATIVE KERATITIS, WITH PANNUS TENUIS.

A patient came to me with relapsing ulcerative keratitis, with pannus tenuis of twelve years duration.

He had been improved by treatment, but relapses had constantly occurred. Roentgenization for eight minutes, daily, for two weeks, followed by *x*-ray and the *50* c. p. violet light on alternate days for five weeks, gave perfect relief, with vision = *20/20*. There was no relapse during the treatment, which was the longest period of freedom during the attack.

SERPENT ULCERS OF THE CORNEA.

Hertel used the *arc light* locally in forty seven cases. They were treated for the first two days with disinfection of the conjunctival sac and tear passages, atropine and warm applications; and, as soon as they progressed, with radiation for fifteen minutes, three times a day. Twenty-five healed without any other interference; thirteen remained uninfluenced, cauterization and incision, also, being of no avail. The functional results were better with radiation than by any previous treatment.

Cauterization.—Martinachi, of San Francisco, in *1873*, was the first to use the galvano-cautery in an infected ulcer.

Knapp recommended it highly for pustular,

fasicular, rodent, serpent and deeper circumscribed purulent inflammation of the cornea.

HERPETIC KERATITIS.

On April 29/10, W. S., aged 23, was brought to me by his oculist, Dr. Happe, of Dubuque, Iowa, for consultation. The patient had had a foreign body removed from the cornea last August. The eyes, from one week after that experience, have been red and painful about every six weeks for four to five days, accompanied by "water pimples" on the lower lids.

Present Attack.—For two days, a central very painful corneal ulcer of the left eye. Vision 20/100.

Treatment.—I advised the use of the 50 c. p. lamp for half an hour on alternate days with the *x*-ray, which should be applied for five minutes.

May 6. Dr. Happe writes that the patient is doing finely. He has a new crop of herpes but the eyes are not involved.

Leprince finds that herpetic keratitis recovers in ten treatments, with effluvation at two days interval; as does also Phlyctenular keratitis. In inflammatory ulcer, the effect of effluve is remarkable and the recovery is rapid.

Parasotti has employed the direct current in one case of keratitis. A great amelioration followed. After several seances the sensibility returned and the ulcer healed.

HERPES ZOSTER OPHTHALMICUS.

A. Mathewson, of Brooklyn, reports a series of successful cases, treated with either galvanic pole.

Personally, I would preferably apply the positive (sedative) pole, with three to four m. a. of current to the external affected areas for ten to fifteen minutes,—and the negative metal electrode, with one m. a. of current, to the eyeball for one minute.

W. G. Mortimer, New York, in the above disease, and in certain painful conditions about the orbit, employs a static current with a spark gap of about one inch, or, so that the application is not felt, —moving a glass vacuum electrode along the affected area and over the globe for from ten to twenty minutes. The application immediately relieves the pain and promotes the cure.

The vacuum electrode, attached to the resonator of the high-frequency coil, will furnish a similar current.(C).

Dr. Larat reports several cases of herpes zoster cured by galvanism. The negative pole, with six to ten m. a. was applied to the affected area for twenty-five to thirty minutes. He gives two applications or more daily. A cure results in twenty-four to forty-eight hours, without the usual consecutive neuralgias.

LEUCOMA.

To Crussel, Russia, in *1841*, is attributed the honor of being the first to employ electricity in the treatment of opacity of the cornea. He applied a conical negative electrode to the edge of the opacity and placed the positive in the mouth.

Neumann, in *1842*, treated patients electrically in such cases, giving two seances daily for a month, and he obtained considerable success.

During the treatment of keratitis, the accompanying opacity will be lessened as the keratitis improves. Hence, no especial treatment of the opacity is required until the eye becomes quiet.

My practice is first to use the medicaments in the treatment of opacity, as they are more convenient than electrical modalities. After applying a Bier's pump to the lids for about two minutes, in order to increase the bulbar injection, I am in the habit of treating the opacity with ten per cent dionin ointment, massaged into the cornea through the lids, once daily. If satisfactory improvement does not follow, after one month, I then use five minims subconjunctival injections of a five per cent. solution of sodium saccharate, repeated every fourth day. If this fails to give relief, I then treat the cocainized cornea daily by a direct application of a negative copper electrode, previously dipped in quicksilver,—limiting the current to one-half to one m. a. I have found that a current of two to three m. a. produced so much reaction that the patient was unable to be treated for a week. It is necessary to test the meter with a standard one to be sure that it registers accurately, when so mild a current is required.

If improvement does not follow this, I then try the effect of radiotherapy, using the *x*-ray with the same technic as in trachoma. Failing here, I try next phototherapy, applying the light with such intensity as the patient will bear, for twenty minutes daily. With all these methods, I have secured good results, but am unable to predict which will prove the most successful in any given case,—except in tubercular opacities, when *x*-ray treatment seems to be the most specific.

I give one illustrative case,—March 26/07. Mrs. J J. M., aged 37, has a central tubercular leucoma of the right cornea, with ciliary injection, of one year's duration. There is a lupus of the nose of twelve years' standing. There are photophobia and blepharospasm.

Vision of right eye = 20/40.

Previous Treatment,—By Finsen light, from autumn to spring, tri-weekly, two years ago. Then, eighteen *x*-ray treatments since Christmas. The nose was much improved. The eye was protected lest the lashes might fall out.

℞. X-Ray with two-inch spark gap. The patient at three inches from the tube, treated tri-weekly, for seven minutes, the nose and the eyes being unprotected.

March *28*. The eye feels better. No ciliary injection.

April *23*. The opacity is smaller. The eye quiet. Vision = *20/40*.

June *27*. Has had *x*-ray tri-weekly for six weeks, and bi-weekly for the last six weeks.

The eye recovered and remained quiet for the subsequent six weeks. It had not been quiet previously for more than two weeks since last July.

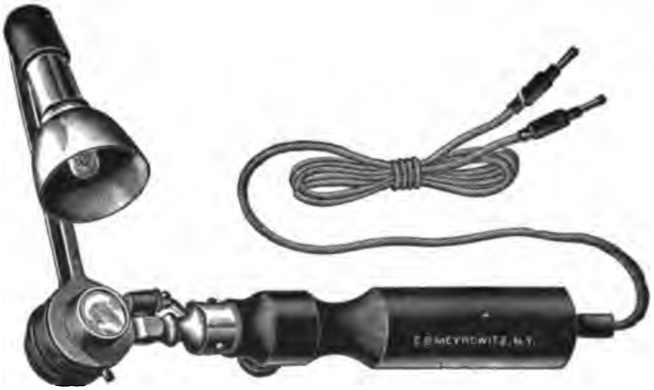


Fig. 101.—Koller's Corneal Loupe With Focal Illumination. (Microscope.)

Alleman, of New York, is a warm advocate of galvanism in the treatment of corneal opacities. He says,—

I concluded that by applying a small electrode to the surface of the cornea, a current of great density would be used directly to the diseased point; and, as the greatest molecular activity is induced at a point directly in contact with the electrode, the indication of limiting the current's action would be fulfilled. I apply the other electrode to the cheek. (Alleman's electrode.) The tip of the electrode is silver, which, plunged into mercury, forms an amalgam that makes a smooth cushion to apply to the cornea. The cathode is applied to the cornea.

I begin with one-quarter to one-half a milliampere, for one minute. Should this be easily borne, I gradually increase the current up to three or four m. a., which I place as the limit of strength. This is followed by a slight irritation which should subside before the next application, which I make after an interval of one day. The strongest current I have used has been four m. a. for three minutes, but I do not think any better results were obtained than by a weaker current at more frequent intervals. One to one and a quarter m. a. will give the best results. I have, with this, frequently produced vessication on the cheek without disturbing the cornea.

The following cases were treated as indicated above:—

December *13/88*. C., aged *19*. Opacity the sequel of ophthalmia neonatorum. Vision = *2/200*. Galvanism used.

March *16*. Vision = *20/200*. Eye is amblyopic.

2. Mrs. H. Has opacity, the sequel of suppurative keratitis, two months previously.

December *18*. The vision = *20/200*. Galvanism is applied, vision five days later is = *20/50*.

3. Aged *36*. Instertitial keratitis for twenty years. The patient could count fingers at eighteen inches. After nineteen treatments, the vision has increased to *10/200*.

4. Aged *28*. Had inflammation eighteen years ago. Vision in left eye with + *5.00* = *20/200*. Galvanism, one-quarter of m. a. for two minutes at twenty sittings. Vision = *20/40*.

5. Aged *54*. Came Jan. *25/89*. Vision = *4/200*.

℞. Galvanism. July *5*, vision = *23/200*.

Patient irregular in attendance.

6. February *3/89*. Had traumatic keratitis eight months since. Vision = *20/200*. Treated with galvanism. Feb. *25*. V. = *20/50*.

7. February *9/89*. Aged *16*. Sequel of ophthalmia neonatorum. Adherent leucoma. Could read Jaeger *8* at *12* inches. Galvanism. In April, could read Jaeger *5* at *12* inches.

8. May *14/89*. Leucoma. Vision = *6/200*. With atropine it is *20/100*. Galvanism used. A year later vision = *20/40*.

9. May *17/89*. Aged *30*. Vision *4.4/200*. With atropine, *20/200*. Advanced tuberculosis. Galvanism applied. July *15*. Vision *20/200*. Not improved.

I do not believe I could have obtained equally good results by any other method, and in most of these cases, the ordinary methods had been tried without benefit. The age of the opacity has little to do with the rapidity of the improvement. I do not begin treatment until the eye is quiet. The vessels are no doubt dilated by the current. They are seen running to the corneal margin or on the scar.

Treatment of Leucoma by Electrolysis.—Pensier, who has applied the current both to the cornea and the lids, concludes that it is useless to apply it directly to the cornea; and that the application to the lids acts equally as well but requires a stronger current—three to five milliamperes—and longer and more numerous seances.

Leprince applies to the lids a current of ten to fifteen m. a. by gradually decreasing it. He considers the results of this means of electrolysis less precarious and the application of the *x*-ray, he has completely abandoned. He says leucomas are not much modified by *effluve,* unless situated at the sclero-corneal margin.

Photo-Therapy in the Treatment of Leucoma.—Sulzer uses the arc lamp of Broca Chatain. A quartz lens (to absorb the heat) of fifty m. m. local distance and forty m. m. in diameter is placed at one hundred m. m. from the arc and a diaphragm is used to regulate the light. The eye is cocainized and a lid speculum used. The eye is exposed for twenty to ninety seconds. The seances are repeated in eight to fifteen days, the number varying from four to twenty.

Employed after electrolysis in superficial opacities or by itself in cases of sclerosis, phototherapy improves the sight.

Sulzer observes that, under the use of the light, tension falls, pupillary exudates are absorbed and that posterior synechia are ruptured. He quotes nineteen cases in support of his conclusions. Sulzer further observes that radiotherapy produces curative effects analogous to those obtained by light treatment, although they are less effective and slower. He also notes that the best application, in opacities, is electrolysis combined with phototherapy; or phototherapy alone in cases of sclerosis which follow interstitial keratitis.

Leprince treated, for two months, a patient completely blind in one eye with a large corneal leucoma. There was no hope of recovery of vision. The patient, aged *45*, had distinguished only light since five to six years of age. At first, Leprince treated the patient for one, then two minutes, four, five, and then ten minutes, in order to know the impression the light made on the eye, and the retina. At the end of a month, the cornea began to clear above and in six months there remained only an opacity in the infero-internal region. A semi-cataract was perceived. The patient distinguished large objects.

Since then, says Leprince, in all cases of sclerosis of the cornea, I have had considerable increase of visual acuity. During the last six months, I use, concurrently, and for small leucoma, intermittent flashes, which permit a longer exposure and give results analogous to those of the continuous exposure.

Usiglio relates three excellent results with galvanism in cases that had resisted all other treatment.

Adler, *1885*, reports five cases treated beneficially with galvanism.—

1. Aged *13*. Leucoma. Vision = *20/70*. After four seances, the vision rose to *20/40*.

2. Aged *18*. Leucoma. Right eye reads Jaeger, No. *5*. Left Eye, Jaeger, No. *3*. After two seances, R. E. = J. *2*, L. E. = J. *1*.

3. Leucoma, limeburn and corneal opacity and ablation. Vision = *1/200*. Twenty-three treatments given between July *3* and August. Leucoma diminishes. Vision = *1/15*.

4. M. Had a cataract extraction on February *8*, with mealy debris left. Two days later, electricity was begun and continued until March *5*. The masses were rapidly absorbed under electricity. March *3*. Vision = *4/8*.

5. Aged *14*. Leucoma. Vision = *3/68*. After three seances, vision *3/10*.

Hubert, in *1886*, employed a bipolar knife (platinum). The current, he considered, must not exceed five to seven m. a. The current produced a slight foam. It was applied for fifty to sixty seconds. The knife was moved to and fro with the result of epithelial detachment. Electricity was renewed in two days. The vision, which was lowered for a week, improved in the second or third week, and not till then was a further treatment given. A notable improvement occurred.

Rogers says that in Leucoma the beneficial results of treatment by the *500* c. p. lamp are largely confined to cases of less than two years' standing. In recent cases, excellent results are obtained.

KERATOCONUS.

Knapp, A. Critchett, Tweedy and Panas agree that, in keratoconus, no other treatment has given them such satisfactory results as the galvano-cautery. Knapp and Tweedy consider the perforation of the cornea essential to success.

Knapp, with a cautery point *3*× *4* m. m. burns, superficially with a red heat, an area from the centre down and out 4 m. m. in diameter, and, after a few moments a smaller zone, and lastly, the cold electrode is placed in the centre of the area and withdrawn immediately when the part becomes red and perforation occurs.

Ball writes that moderate cauterization is followed by prompt healing and limited scars, while extensive burning causes iritis, suppuration and sloughing of the cornea. He considers that perforation of the cornea should be avoided but that it is not necessarily followed by bad symptoms. At least one-half of the pupillary area should be spared.

Dr. Swan, of Chicago, reports the following case of keratoconus:

June *28/07*. Mrs. G. A., aged *32*. Has had diplopia for ten years. Double conical cornea. Her younger sister is getting the same trouble. The left eye, which is the poorer, can distinguish *6/200*.

Operation. The apex of the cone was burned with the electro-cautery, without perforation; and, six weeks later, an artificial pupil was made.

Vision improved to *20/200*, with *5.00* cyl. axis *45*°.

SCLERITIS AND EPISCLERITIS.

The treatment of scleritis and episcleritis, by local and general medication, had been perfectly ineffectual and the disease seemed, uninterruptedly, to run its course, until I commenced to treat it by means of the *x*-ray; and since then, the disease has invariably yielded in a moderate length of time. I quote several illustrative cases,—

1. Mrs. —, aged *42*, had had previously several attacks of episcleritis treated by me with antirheumatic drugs and local applications of dionin, etc., without apparent benefit,—the condition seeming to run its course to its limit. The patient has, for a lengthened time, been afflicted with rheumatic arthritis of the finger joints. At present, the eyes present episcleral nodules, and are moderately painful.

After twenty exposures to the *x*-ray tube, with a low vacuum, at six inches, for five minutes, tri-weekly, the nodules and pain completely disappeared.

2. Miss —, aged *25*, has episcleritis. She has not been free from scleral nodules on the right eye for three years, or on the left for two, in spite of the care of three oculists. A small nodule disappeared after four irradiations, and a large one after six. Recovery, after tri-weekly exposures for six weeks, with a low tube, and no recurrence in three years.

3. L. G., aged *25*. Consulted me June *17*, *1907*. There was an episcleral nodule on the left eye, of three years duration. This has been painful at times and not relieved by any treatment. History,—Antecedents were rheumatic, but the patient is not. ℞. *x*-ray, with low tube, at four inches, for eight minutes daily. Recovery in four treatments.

4. Miss M. G., aged *18*, consulted me October *28*, *1907*, having episcleritis of both right and left eyes.

The right eye was attacked in May and recovered in July, under the car of Dr. Pattillo, of Chicago. The left eye was attacked about the middle of June and has since frequently nearly recovered and again relapsed.

Present State.—Right eye has very slight episcleral injection to the temporal side of the cornea. Left eye has decided pink injection of the whole sclera. There is an episcleral nodule on the nasal side. General health,—very anaemic.

Previous Treatment.—For four months past, she has been under the care of Dr. Pattillo, who gave her manganese internally and dionin, protargol, and *50* c. p. lamp to the eyes with little improvement; and then handed the patient over to me for treatment.

Under *x*-ray, daily, for eight minutes, she completely recovered in six weeks.

5. Miss B., aged *32*. Consulted me March *5*, *1909*. There has been an episceral nodule on the nasal side of the right cornea for one week. She had four to five attacks last summer, which disappeared in two weeks. She had sciatica and rheumatism in the arms.

℞. *500* c. p. lamp for fifteen minutes daily. The nodule disappeared in one week.

Treacher Collins has, lately, shown that these nodules are usually tubercular, which probably accounts for their yielding so promptly to *x*-ray treatment.

Leduc, in scleretis and episcleritis, applies the positive pole to the body, while the negative pole, saturated with cloride of sodium, is applied to the closed lids for a quarter of an hour,—the current being gradually increased from five to six m. a. This he repeats tri-weekly.

A certain number of cases that had been ineffectually treated with potassium iodide and salicilate recovered rapidly under this treatment, and without any relapse. The pain disappeared very rapidly and the recovery was prompt.

Leprince cites two cases of episcleritis, to which he applied the *x*-ray,—one recovered after one séance of five minutes, the other after three treatments.

1. Aged *27.* Has episcleritis accompanied with much sub-conjunctival hemorrhage. On November *16*, treated with the intermittent *x*-rays, *200* interruptions per minute, for five minutes. This was repeated on Nov. *19* and *21*, after which, the hemorrhage, which had occupied the superior half of the globe, became absorbed and the nodules disappeared.

2. A lad of *17*, with double episcleritis, recurring. Dec. *7*,—X-ray, with *150* interruptions per minute, for five minutes to each eye. Dec. *10*, this repeated. Dec. *13*,—Recovery is complete.

Use of the High-Frequency Current.—Leprince says that scleritis and episcleritis always recover by the effluve of the high-frequency current.

The cases treated by Billinkin and Leprince have invariably been successful. The electrode to employ is the same as in affections of the conjunctiva; applications for five minutes every second day.

Darier finds punctuate cauterizations of the scleral nodule useful.

Rogers cites the following case, referred to him by Dr. A. M. Brown,—

Mr. C., aged *37*, who had rheumatism several years previously. In November, *1908*, he felt pain in the left eye, which was diagnosed as episcleritis by a specialist. The treatment was unavailing, the pain increased, and by April, *1909*, there was only light perception.

℞. Treatment by the *500* c. p. lamp. The pain was completely relieved after the eleventh treatment. In three weeks, the patient could distinguish faces and the case progressed to complete recovery.

Alleman reports a case of episcleritis relieved with positive galvanism, one-half to one and a half m. a. of current, applied to the globe, gradually increasing the time to three minutes.

Pardo has treated scleritis by the *x*-rays and claims that "these rays represent a real discovery, inasmuch as there is, up to the present day, no other direct therapeutic agent existing, but only methods amounting to a purely symptomatic treatment."

CHAPTER III.

IRIS, CILIARY BODY AND CHOROID.

IRITIS.

The treatment of acute iritis necessitates local and internal medication and the results are extremely satisfactory. Still I am wholly satisfied that the treatment of the eye by phototherapy at the same time tends very much to relieve the pain and greatly accelerate the recovery.

T. N., aged *32*, has had considerable pain in his eye for two days. There is moderate conjunctival injection with *20/20.* of vision and iritis.

℞. Atropine one per cent., dionin two per cent., in a saturated solution of boric acid dropped in the eye every three hours, and aspirin, grs. *10*, taken every three hours. Patient was advised to return in two days. He did not return until November *20*, nine days subsequently. The druggist had mistakenly put up the collyrium one-fifteenth of the strength prescribed. On the *12*th and *13*th the eye was comfortable, but very painful since. The pupil is not dilated. November *20*. Vision = *20/40.*

℞. Repeat the prescription of Nov. *11*.

From November *20* to December *1*, the eye was exposed four times, at twelve inches, to the *500* c. p. lamp. At the end of each of the first three applications, the existing pain was almost completely relieved and recurred afterwards less and less severely. At the fourth, the eye was well, with *20/20* of vision.

The relief from pain and the recovery were much more rapid than I have seen in any similar case under the usual routine treatment.

Dr. D. B. D. Beaver, of Reading, Pa., reports the following case,—A musician, with rheumatic arthritis and iritis and with the cornea almost totally cloudy, was practically blind. Six weeks of general treatment and massage to the eyes produced no change in vision and the patient could not see to walk alone. After negative galvanism to the eyes and positive to the nape of the neck, for ten minutes every second day for eight months, the cornea completely cleared and he resumed his occupation.

Weisflog reports a severe case which recovered after hourly faradizations on three successive days.

Alleman, New York, writes "With one to one and a half m. a. of negative galvanism to the lids, I have seen the breaking up of adhesions and the improvement of vision."

I have not been able to break up adhesions with galvanism. In one case in which it failed, one application of ten per cent. dionin succeeded.

RESULTS OBTAINED FROM THE USE OF THE BLUE LIGHT.

A. B. Dorman, Winthrop, Mass., reports the following case of recurrent rheumatic iritis.—

November *11/05*. Mr. T., aged *35*. Has suffered attacks for six years, about yearly, and lasting six to fourteen weeks, suffering severe pain and loss of sleep for weeks. He had consulted eye specialists for the attacks with little benefit. The attacks seemed to have run their own course. I placed the *50* c. p. Minim blue light fourteen inches from his eye, and followed this with five or six other treatments daily. His suffering was at an end after the first fifteen minute treatment, and in three years he has not had another attack.

The following case I treated with violet light.—

Mrs. S. A., aged *41*. Has had diabetes for a year, when she consulted me on April *15/02*. Vision of left eye *20/40*, with correction. The lens clear. There is incipient optic atrophy on the temporal side.

May *8*. ℞. Violet light, *50* c. p. for half an hour bi-weekly.

May *28*. Vision *20/25*.

Rogers says that in in Iritis the *500* c. p. lamp should be used as in conjunctivitis. The fibrinous exudate which causes synechiae is more quickly and certainly absorbed by the light rays than by any agent previously employed. If there is systemic infection, the treatment should also be general.

SEQUELAE OF SPECIFIC RELAPSING IRITIS.

In this case the right improved from seeing fingers at ten inches to *20/200*, and left eye from seeing light only to *20/70*.

Mr. —, aged *42*. During the past eighteen months, he had been treated by different oculists, chiefly with mercury and iodide of potassium, without any improvement in vision, which remained as it is at present.

Examination shows that there are fleecy opacities in each vitreous and an alternating strabismus.

Treatment,—Positive galvanism was applied to the lids for ten minutes daily for two months, when vision was R. E. = *15/200*. L. E. = *15/120*. Galvanism was discontinued. After vibratory pneumatic massage for five minutes daily to the eyes for twelve days, vision remained the same. The high-frequency current with vacuum electrode to the eyes was then tried for ten minutes daily for ten days without improvement. Galvanism was resumed and dionin five per cent, used daily for six months, when vision improved from seeing fingers at ten inches to *20/200* in right eye and from light perception only to *20/70* in the left eye.

2. —, aged *55*. Sequelae of iritis. Right eye has capsular and vitreous opacities. Left eye similar. Vision had failed for many years. The right eye improved from seeing fingers at eight feet to *6/50*. Left eye slightly, after twelve galvanizations.

SEROUS IRITIS.

Ziegler reported to me that he had cured many cases in two to three weeks with galvanism which would usually require two to four months with other treatment.

IRITIS WITH HYPOPION.

Erb reports, as result of twenty cases treated, that mild cases are cured in a day, more severe ones in four to seven days by a fine sponge galvanic electrode, applied to the lids.

DISEASES OF THE IRIS AND OF THE CILIARY BODY.

Leprince advocates the use of the continuous current in iritis and irido-choroiditis, asserting that diminution or cessation of pain immediately follows its application. In syphilitic iritis, it is an important adjunct of mercury. In serous iritis, the only immediate result of the use of the direct current is the diminution of the pain. Without iridectomy, electricity seems to have little effect upon the inflammation. In chronic iritis, with synechia, galvanism moderates the irritability and augments vision. It diminishes or abolishes the synechia and exudates.

IONOTHERAPY.

Leduc has treated, by ionotherapy, episcleritis, iritis, and irido-cyclitis with much success.

In some grave cases of syphilis of the anterior segment, in which, the patient has been saturated with mercury, Keuckmann recommends mercury on the positive electrode applied to the sclero-corneal limbus. He produces a circular vascularization comparable with that of tuberculin injection. He has treated twenty-eight cases of this kind with success.

TREATMENT OF IRIDO-CYCLITIS WITH RADIOTHERAPY.

Leprince has treated, since *1907*, six cases of irido-cyclitis by continuous *x*-rays, without exceeding four irradiations. The recovery has always been more rapid than with atropine alone. I cite one illustrative case,—

Youth, had trauma fifteen days previously. February *2/07*, the eye had subnormal tension and scarcely light perception, perforation of cornea, traumatic cataract and plastic irido-cyclitis. I considered enucleation necessary.

Twenty-four applications of the *x*-ray from the *2*nd to the *14*th of February, */07*. On April *3*d, the eye had recovered its normal tension. On the *5*th of June, the cataract was extracted with complete recovery.

The two following cases were treated by Coover, of Denver with intermittent *x*-rays.

1. Aged *47*. January *4/07*. Right eye has been inflamed for four days.

Symptoms are,—nebulous cornea, pupillary exudate, ciliary pain. Atropine; Jan. 6, exudate, and pain increasing.

Jan *7*. ℞. X-rays.

Jan. *8*. Amelioration, repeat *x*-rays.

Jan. *9*. Exudation nearly disappeared, repeat. X-rays on Jan. *11*, *13*, *15*, *16*.

Jan. *27*. Complete recovery.

The patient was tubercular and syphilitic and had no constitutional treatment.

2. Aged *65*. January *4/09*. Eighteen years ago, the left eye had been operated on for cataract and a plastic iritis with total loss of vision followed.

Some years later, an iridectomy was performed, followed by iritis; and, later, another iridectomy and treatment with potassium iodide for some months without any improvement. Vision = light perception.

Jan. *4*. Intermittent *x*-ray. At the end of the sixth treatment the patient could see objects at sixteen inches.

She had ten irradiations. After each, objects could be seen more distinctly. Vitreous opacities cleared, so that now the red reflex of the fundus could be seen.

Pensier has used the continuous current with success. He cites a case of irido-cyclitis from a blow on the eye.

July *21/94*. A sergeant menaced with sympathetic ophthalmia. Enucleation of right eye was proposed. December *5/94*, Dr. Pensier was called in consultation. He advised treatment first. Current of two to four m. a. twice daily, negative to the lids, positive to superior sympathetic glanglion, for twenty minutes. Amelioration on the twentieth day.

Improvement steadily during January and February. By the middle of February vision about *1/20*. Patient left hospital.

In *1842*, Newman used electricity in posterior synechia with cataract, and opacity of the cornea, for which galvanism is almost always indicated.

Usiglio reported that he has cured by galvanism cataracts which were considered inoperable.

MYOSIS.

In myosis, Teulon advises the negative pole to the eye and the positive behind the ear. In two or three treatments the myosis is cured.

Alleman reports most satisfactory results from one to one and a half m. a. of negative galvanism to the lids, in these cases, with treatments for five minutes.

ANTERIOR SCLERO-CHOROIDITIS.

Mrs. R. T. B., aged *28*, consulted me November *10/09*. The left eye began to trouble her eight years ago and recovered. Two years ago, the eye was again attacked and the sight was much impaired. The appearance of the eye was very much as at present. She was then under the care of Drs. Snydaker and Goodkind. The latter did not find any lung trouble, but put her on a diet of raw eggs and milk and had her sleep out of doors. The eye improved considerably but a relapse occurred last January.

The right eye began to trouble her a week ago.

Present State,—Vision R. E. = *20/33*. L. E. = *20/100*, with correction.

R. E.,— Bluish-pink discoloration of the sclera above the cornea and a red area below the lower half *1/8* to *1/4* lines wide. L. E.— There is a dark discoloration of the sclera *1/4* to *3/8* lines in width around the cornea and more red area up and in. Cornea has moderate opacity at the margin. Syphilis negative. Pulse *90*. Appetite good. Bowels, up to one year ago would move only weekly without medicine but they were kept regular.

Diagnosis:— Deep scleritis. (tubercular?).

I had both blood and urine examined by Dr. Harrower, with the following result.

BLOOD COUNT.

Homoglobin=75%.

BLOOD SMEAR.

Differential count of 400 Leucocytes:

NORMAL CELLS.			PATHOLOGIC CELLS.	
Small Lymphocytes;—30.		(22—25%)	Myelocytes:	. . .5.0
Large Lymphocytes	1.	(3— 6%)		
Polymorphonuclears—54.		(70—72%)		
Eosinophiles—	7.	(2— 4%)	Poikilocytes:	many.
Mast cells—	2.	(5%)		

Otherwise normal.

EXAMINATION OF URINE.

PHYSICAL.

Specific Gravity,	1.007.	(1,015—1,015)
Total Solids, Gm.	21,20.	(50—70 Gm.)

CHEMICAL.

Acidity, Deg.	50°	(30°—35°)
Acid Units	62,500	(40,000)
Indican	trace	(none)
Urea%	1.6	(2.—2.5%)
Urea tn 24 hours	20.0	(30 Gm.)

MICROSCOPICAL.

Organized elements, Practically nothing.

Treatment:—I prescribed *x*-ray, with low tube at four inches for five minutes daily.

November *16*. Von Pirquet's tubercular vaccine test positive.

℞. Magnesia sulphate and sodium carbonate daily.

Dec. *4/09*. The eyes feel much better; much less injection.

The scleral nodules are both smaller and less red.

℞. X-ray flashing, *120* a minute for six minutes daily.

Dec. *14*. Vision R. E. = 20/*25*. L. E. = *20/66*.

Pain and smarting have disappeared.

January *15/10*. Vision, R. E. = *20/25*. L. E. = *20/50*.

The patient has had two tuberculin injections in the past three weeks.

Jan. 24. No treatment since Jan. 15.

The right eye is more injected and does not feel so well. R. E. = 20/33. L. E. = 20/50. "quiet and fine."

℞. Resume the *x*-ray.

March 26/10. R. E. = 20/33. L. E. = 15/100.

The right has no pain, injected. Left eye is quiet.

℞. Atropine in right eye.

March 28/10. By careful refraction,—R. E. or L. E. = 20/25.

The patient goes to the country for a vacation.

June 16/10. Returned, comfortable, but the sight of the right eye is poorer. Vision, R. E. = 20/50. L. E. 20/25.

R. eye, the cornea is cloudy; brown-red discoloration three lines wide surrounds the cornea.

℞. Dionin in right eye, *x*-ray and high-frequency auto-condensation couch for fifteen minutes, tri-weekly.

August 6/10. Vision = in right eye, 20/25; in left, 20/33. The patient discharged.

The patient improved, upon the whole, remarkably under treatment, considering that, in my opinion, the case is incurable.

CHOROIDITIS.

Mrs. H. F., aged 54, consulted me Aug. 20/07.

Her sight has been failing for five to six years, but much worse during the past year. She sees spots floating in front of the eyes. Vision R. E. = 20/40; L. E. = 20/100. Not improved with glasses.

Disseminated atrophic choroiditis of left eye.

Small white dots in right choroid.

℞. The alternating current for ten minutes daily to the eyes.

December 18/07,—Vision R. E. = 20/40; L. E. = 20/40 +.

Stop treatment.

October 17/10,—Has not had treatment since May last; Vision R. E. = 20/50, L. E. = 20/40 — 2

℞. The alternating current every second day to the eyes.

March 23, Right or left eye vision improved to 20/33.

Rogers says that in choroiditis the 500 c. p. lamp should be applied locally as for conjunctivitis; and generally in systemic cases. He cites a case which had been under treatment for several weeks, and in which vision was 20/100 at the time the light was first applied.

He subjected the patient to the light for five minutes at first, longer afterwards. An hour after the third treatment, the vision had risen to 20/30. The structures appreciably cleared from day to day.

In the atrophic stage, he says, if the patches be not too large or numerous, the degenerative process may be arrested even if the atrophic structures cannot be restored.

CHAPTER IV.

THE CRYSTALLINE LENS.

THE TREATMENT OF CATARACT BY ELECTRICITY.

Pensier has given us interesting items regarding the earliest experimentation with electricity in the treatment of cataract. He writes,—

The first attempt at the cure of cataract with electricity begins with Knox, *1879*, who claims he cured two cases with *electrical effluve.*

Neumann observed, in *1842*, the effects of galvanism in two cases. In the first, the cataract was complicated with synechia. Neumann employed a pile dipped in a solution of sulphuric acid. The zinc pole was put in the mouth of the patient, the copper pole was attached to a copper needle which was pushed into the centre of the lens. The result was nil.

The second case was one of secondary cataract. With the same procedure he obtained a notable improvement.

(How much the result of the needle was due to the merely mechanical effect and how much to the current could not be determined, though, I believe the current could have contributed very much towards the result—and would be worth trying in secondary and soft cataracts.)

"Usiglio, in *1844*, treated by galvanism three cataracts absolutely incurable by surgical methods. The negative pole was applied to the tongue, the positive to the closed eye. Two of the cases treated lost the vision; the third recovered completely."

In *1852*, Graefe stated that applications of the negative pole of a galvanic current to the eye have been successful in the treatment of cataract.

The attempt to dissolve a cataract by galvanopuncture has been made by Crussel (Russia), with the result of inflammation and destruction of the eyeball. (Beard and Rockwell).

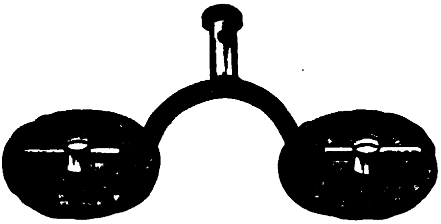


Fig. 102.—Binocular Electrode.

The fatality may have been due to infection or too strong a current. Needling of senile cataract with the negative pole and *2* to *4* m. a. of current for five to ten minutes and repeating, if necessary, would be safe and might be satisfactory.

Crussel claimed to have obtained perfect success in cases of cataract, by introducing the negative galvanic needle into the lens,—positive on the tongue. Thus the lens was subjected to mechanical and aqueous disintegration and to the chemical influence of the negative pole.

Neftel reported two cases of undoubted beginning cataract, in which, vision was completely restored and objective symptoms disappeared by negative galvanism to the lids ten to fifteen minutes, daily, at first, then less frequently.

After trying the tolerance of the patient, I see no reason, in most cases, for the common practice of lessening the frequency of electric treatment, than there would be to prescribe an alterative or tonic drug once or twice weekly instead of t. i. d. In most chronic cases, my pracice is to give twenty minutes treatment daily, in place of three to five, with any current, and when long periods are necessary, to, occasionally, intermit the treatment completely.

A. J. Irwin applies iodine over the eyelids and galvanism for five minutes daily, for at least a month, using two to five dry cells. (The negative sponge is probably used, and *4* to *7* m. a. for twenty minutes would be advisable.)

A physician, Toronto, Canada, reports two cases treated by a *500* c. p. incandescent lamp. Vision improved from *20/30* and *20/40* to *20/20*, and all opacity disappeared.

Samuel J. Harris, of Boston, who has had success in the treatment of cataract with electricity, writes on the subject as follows, instancing with cases, —

Technique.—To do the most good, says Dr. Harris, it is necessary to give from *5* to *15* m. a. of current. To do this, I had made two eye cups, connected by rubber tubing to a metal center-piece, for the attachment of the cathode. Inside the cups, a metal disk connects with the center-piece. The cups are filled with clay or antiphlogistine, then covered with chamois and tied with rubber. The cathode is attached to the cups placed over the eyes; a large pad is placed at the nape of the neck and fastened by a collar.

The cups and pads have, previously, been saturated in salt solution; the current is turned on gradually until *10* to *12* m. a. are reached, or a slight burning is felt. This is kept up from ten to fifteen minutes for ten to fourteen days, then, every other day until improvement occurs, then the sittings are gradually lengthened until the patient is cured. This may take from two to twelve months, depending upon the condition of the cataract.

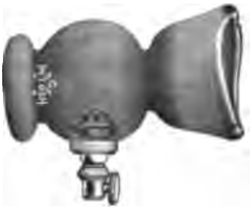


Fig. 103.—Eye Cup Electrode for Direct Current.

CASES.

Case *1*. Mrs. A., aged *66* years, has had incipient cataract for one and a half years. Vision R. E. = *20/60*. L. E. = *20/50*.

Four months treatment. R. or L. = *20/20*. No lines or nebulae.

Case *2*. Age *72*. Cataract was diagnosed thirty years ago.

Vision R. E. = *20/200*. L. E. = *20/100*.

The patient was treated daily for three weeks, then, gradually the seances were reduced to one a week, for six months.

R. E. = *20/40*. L. E. = *20/30*.

Case *3*. Age *70*. Patient has had cataract for two years.

Vision R. E. = *20/300*. L. E. = *20/120*.

After three months treatment, the vision had increased to R. E. =*20/80*. L. E. = *20/60*.

Patient is still under treatment.

Case *4*. Age *72*. Cataract was diagnosed thirty years ago. R. or L. *20/200*.

After treatment for four months vision was, R. E. = *20/40*. L. E. *20/40*.

Case *5*. Age *80*. Cataract is of two years duration.

Vision R. E. = *20/100*. L. E. *20/80*.

After treatment for one month, the vision of each eye was *20/20*, and two years later, remains the same.

Case *6*. Age *40*. Vision R. E. =*20/100*. L. E. = *20/80*.

After two months' treatment, the vision of both eyes is *20/20*.

There are no opacities.

Case *7*. Age *65*. Has a cataract of seven years standing.

Vision R. E. = *20/80*. L. E. = *20/100*. After three months treatment, vision is raised to R. E. = *20/30*. L. E. = *20/40*.

CONCLUSIONS.

Mature cataract, I have not treated by electricity, because I prefer to operate on such cases. Incipient cataract can be cured, provided the oculist is an expert in the use of electricity, and the patient is treated by the method described.

Some cases improve immediately and others remain stationary for a long time and then improve. Some cases improve all they will in the first month and then remain stationary.

In all cases, in which the disease is progressive, and where there is not cirrhosis of the liver or kidneys, diabetes or organic diseases of the heart or lungs, improvement may be expected. Where the vision has remained stationary for some time, and there are structural changes in the choroid and retina, I have never seen any improvement.

In most instances of incipient cataract, the progress of the disease can be checked, and often a complete cure results."

Dr. S. T. Anderson, of Bloomington, Illinois, presents a case of cataract treated with electricity, in which a very satisfactory result was obtained.

Patient aged *45*, nearly blind, cataract in both eyes.

Treatment.—Weak galvanic current was applied to the eyes for one or more hours twice daily.

Result.—For six years, the patient has been wearing glasses with satisfaction. She now has good vision.

In *1887*, J. Elliot Colburn, of Chicago, who had been doing considerable experimentation with galvanism in certain types of cataract, wrote an article in which he classified his cases as follows,—adding interesting comment.

He arranges the cases in four groups.

Group *1* includes those cases in which there was no improvement.

Case *1*. Mrs., aged *49*. Vision R. E. = *15/80*. L. E. = *15100*.

Long narrow spikes to centre of lenses, no nebulae, no change in vision for two years. Fifteen treatments were given in one month. Later, glaucoma developed in right eye.

Case *2*. Mrs., aged *52*. R. E. = ? L. E. = *20/60*. Many long spikes; no nebulae. She had occasional sittings for two and a half months.

Case *3*. Mr., aged *54*. R. E. = *20/80*. L. E. = *20/40*. There were spikes, calcareous deposits and much nebular matter.

Group *2* includes cases that have been under observation from four to seven years, in which the improvement has been permanent.

Case *1*. Mrs., aged *50*. R. E. = *15/100*. L. E. = *15/60*.

After treatment for four months, R. E. = 20/30. L. E. = 20/20.

Case *2*. Mrs., aged *52*. R. E. = *15/40*. L. E. = *15/60*.

After treatment for two months, R. E. = *15/30*. L. E. = *15/15*.

Case *3*. Mrs., aged *57*. R. E. = *20/100*. L. E. = *20/100*.

She had had loss of vision for two months. Forty treatments were administered in four months, when vision had increased to R. E. = *20/80*. L. E. = *20/60*. Eighteen months later, vision had improved still further.

Case *4*. Mrs., aged *63*. Vision R. E. = *15/100*. L. E. *15/200*.

After two months treatment, R. E. = *15/40*. L. E. = *15/100*.

Case *5*. Mrs., aged *70*. R. E. = *15/100*. L. E. = reading No. *5* Snellen. Patient had been losing sight for six months. After treatment for four months, vision is R. E. = *15/30*. L. E. =*15/20*.

With glasses, she reads Snellen No. *1*, can thread a fine needle and do fine sewing.

Case *6*. Mr., aged 54. R. E. = *20/80*. L. E. = *20/100*.

He had thirty sittings in three months, when vision had increased to R. E. = *20/20*. L. E. = *20/100*. Four years later, —R. E. = *20/90*. L. E. = *20/100*.

Group *3* includes cases in which there has been complete removal of lines and nebulae.

Case *1*. Mr., aged *49*. R. E. = *20/40*. L. E. = *25/30*. Peripheral cataract R. E. long spikes reaching nearly to centre of lens and dense nebulae; L. are long and many shorts spokes; slight nebulae. Twenty-three sittings in two and a half months, when R. E. and L. E. were both *20/20*, and Snellen No. *1*. No change two and a half years later.

Case *2*. Mr. aged *54*. R. E. = *15/40*. L. E. *15/15*. Short lines and nebulae. Daily treatment, for three weeks and occasionally for two months. Vision normal in both eyes; no sign of degeneration of the lens two and a half years later.

Case *3*. Mrs. aged *63*. R. E. = *20/20*. Snellen No. *2*.

After daily treatment for three weeks, could see no lines or nebulae in left eye; in the right eye, nebulae had cleared, leaving lines unchanged. Four years later, no appreciable change in either eye.

Group *4* includes recent cases, in which there has been complete absorption of opacities.

Case *1*. Mrs. aged *63*. R. and L. V. =*20/20*. Reading Snellen No. *8*. Peripheral cataract in both eyes. Three months previously, the doctor had diagnosed cataract. After one month's treatment, with ten sittings, R. and L. V. *20/20*. No lines or nebulae visible; reads Snellen No. *1*. Nine months later vision *20/20* and no sign of opacities.

Case *2*. Mrs., aged *68*. Myopic; R. E. = *20/100*. L. E. = *20/200*

Slight radii in both lenses. After twenty-four treatments in one month, only one or two lines are visible. Four months later, patient has fully recovered; can see no lines or nebulae.

Groups *2* and *3* are cases of peripheral cataract, all having lines and nebulae.

The nebular matter is slowly absorbed, leaving the former gray portions of the lens clear and transparent and the lines clearly marked. I have never seen radii that were fully degenerated become absorbed.

In all cases, in which the disease is progressive, as indicated by the fat granules and nebulae, and when the choroid and retina are not greatly degenerated and when there are no complications of kidneys or liver, diabetes or organic disease of heart or lungs, improvement may be expected.

The cases in which improvement is not to be expected are those in which vision has remained stationary for some time, and where there are structural changes in the choroid and retina.

Treatment. — The negative electrode placed over the eye, the positive at the nape of the neck, or the angle of the jaw. The cells should be slowly turned into the circuit until a slight vertigo is experienced, then gradually increase the number of cells, the sittings occupying five to ten minutes, at first daily and decreasing to one to two a week."

With the reliable meter of today, *3* to *7* m. a. for twenty minutes, daily, may be used, and "vertigo" should be avoided. The above remarkable success well deserves further trial, and it might be still more useful in soft cataract.

Dr. Holford Walker, of Toronto, Canada, writes of "Light and Vibration versus Operation" and cites an interesting case. Mrs. T. J., unable to read as well as formerly. Her oculist diagnosed a forming cataract in each eye. I used a *500* c. p. lamp directly to her eyes and to the cervical region daily, for five to seven minutes, for seven weeks; and mechanical vibrations on alternate days to the cervical region.

I found, when Mrs. J. came first for examination, streaked opacities of the right lens and more of the left. Lens milky. Vision R. E. = with lens, *20/30*. L. E. = less.

At the last examination, subsequent to the light treatment, vision, R. E. = with lens, *20/20*. L. E. with lens, *20/20*. Both lenses perfectly clear.

Leprince, of Bourges, writes,—"Science knows, at the present date, no well established case of the cure of cataract by physical agents." Doubtless he had not seen the above reports.

Darier writes, "Medicamentous electrolysis may be an excellent means of treating incipient cataract, saturating the anode with potassium iodide." The direction to apply potassium iodide to the anode is evidently a mistake. The medicament should be applied to the cathode in order to get the effect of iodine by cataphoresis, as iodine travels towards the positive pole.

Of the Treatment of Cataract by the *500* c. p. Lamp, Rogers writes,—"If the lamp's rays be applied during the incipient stage, the cataract will usually be cured.

In all juvenile cases, excepting those due to incurable diseases, soft cataract yields readily to raying (lamp). In any case the time required has been but two or three weeks, and in case of failure, recourse may be had to needling. The rays usually fail in mature cataract. In senile cataract and in cases in which it is due to incurable disease, two general treatments of half an hour, daily, are advisable, as well as local treatment."

CHAPTER V.

THE VITREOUS.

OPACITIES OF THE VITREOUS.

Opacities of the vitreous, whether due to hyalitis, choroiditis or hemorrhage, are, in the early months, absorbed either by the force of nature, or, still more rapidly, by hypodermic injections of pilocarpine and the administration of mercury and iodide of potassium.

After the condition has continued for any time from three months to several years, I have found a treatment by the application of the direct current to be much more effective than any medication,—the result being exceedingly satisfactory in nine-tenths of the cases. The condition indicates the use of an electrolytic current, and electrolysis, by consensus of opinion, is the function, *par excellence,* of the direct current. Hence we use the direct current.

Personally, I believe that the alternating current is also distinctly electrolytic, though I have not yet had the opportunity to test the subject clinically in a large number of cases. Still, in some cases in which the direct current has ceased to benefit the patient, I have secured further improvement in vision by the use of the alternating current. In the application of the direct current, I am in the habit of applying the negative electrode to the lids and the positive to the nape of the neck, with a current of three to seven m. a. for twenty minutes daily: or an alternating current to the lids and neck, with a voltage of ten to twenty-five, for twenty minutes daily.

1. E. C., aged *63*, consulted me March *15/07*.

There were large and cobweb opacities in each eye.

Vision of either eye, without correction, *1/5*.

I prescribed application of the direct current.

April *8*,—The patient has had only eight applications of galvanism to the eyes; vision remains the same after these few treatments. She says "During the year just preceding these electrical treatments, I awoke nightly with burning, twitching and pain in the eyes, but I have had none of these symptoms since, except when I am very tired."

2. Mrs. I. H., aged *38*, consulted me November, *20/07*.

In the left eye, there are floating opacities in the vitreous. The sight had failed suddenly four years ago and remains the same. Large and dust opacities fill the vitreous. She has constant occipital headache and has scarcely been able to sleep for two months. Vision L. E. with + *2.00* = *20/200*.

Previous Treatment,—Two years ago for three months, and in hospital for one year without improvement.

℞. Negative galvanism to the lids with *7.50* m. a. for fifteen minutes tri-weekly.

December *23*. She has not had any headache and has slept well for three weeks. The vitreous opacities remain the same.

The following chronic cases of vitreous opacity, under my care, were treated with negative galvanism to the lids with remarkable results as to the percentage of the cases benefited and the amount of visual improvement.

1. —, aged *64*. The right eye had failed in vision lately, the left eye had been failing for four years.

The patient was put under galvanism daily for a month, with the negative electrode to the lids, five m. a. of current for twenty minutes.

Vision rose in the right eye from *6/12* to *6/6*; in the left eye from *6/50* to *6/15*.

2. —, aged *54*. Sight failing for one year. Epiphora constant. Galvanism was applied daily for a month, the negative electrode to the lids. The epiphora ceased completely, and vision rose in the left eye from *20/70* to *20/40*.

Seventeen cases of chronic opacities of the vitreous I treated similarly with the direct current.

Five of these cases had only light perception. Of these, one improved so that the patient was able to count fingers at six inches.

The remaining twelve cases had form perception. Ninety per cent of the whole number had very gratifying results. Two of them improved forty per cent. in vision; four of them twenty to one hundred per cent; and six two hundred to seven hundred per cent.

Girard Teulon thinks that galvanism is the most effectual and rapid remedy in cases of opacity of the vitreous.

Abadie and Terson have obtained surprising results by thrusting an electric needle eight m. m. into the vitreous.

E. L. Kniskern, of Centralia, Washington, reports a case of a workman, aged *60*, who had a large opacity in his only eye which had been getting blind for one year. He had to be led about. The blindness increased during many weeks of treatment. After a year's treatment with the *x*-ray, with intervals of a month or two, a delicate skeleton only of the opacity remained and the man returned to his work.

Little and Gunn report remarkably favorable effects of the use of faradism. As the former gave mercury and potassium iodide freely, and the latter potassium iodide, the treatment is a mixed one and the claim cannot be said to be substantiated.

Ziegler treated a case for two years with iodides with vision *25/200*. Later he treated it for six weeks with positive galvanism, when the vision rose to *20/40*.

While the polar effect near the electrode is to liquify organic matter at the negative and harden it at the positive pole, and this suggests the application of the negative to the eye, it is probable that the direction of the current, so far as it affects the interior of an organ, is immaterial; besides many have used the positive to the eye with good results.

Rogers offers the following technic for treating opacities of the vitreous with the *500* c. p. lamp,— The light should be applied for a few minutes over the upper part of the body, then, to the orbital region, temples, forehead and face for twenty minutes.

INTRA-OCULAR HEMORRHAGE.

The following case of intra-ocular hemorrhage in the right eye I treated with galvanism for three months. From having *light perception only,* vision rose to *normal.*

Dr. S., aged *39*, had, three months previously, lost consciousness for twenty-four hours, and, upon recovery, found the sight of both eyes was completely lost. Light perception only remained for one week, when a relapse occurred and he was again unconscious for twenty-four hours.

He had consulted some six or eight oculists, who agreed that he had intra-ocular hemorrhage. There was also a diagnosis of leucocythemia and acute toxemia.

The patient was an inveterate smoker. Syphilis negative. He had been under the care of the late Dr. Hotz, whose unusual ability none would question, and was treated internally with mercury and iodide of potash, with sub-conjunctival injections of hydrarg-cyanide and with pilocarpin injections, etc. The left eye recovered normal vision but the right eye did not improve in light perception.

Three of the consultants had agreed that the eye was hopelessly blind, when Dr. Hotz referred the case to me for treatment.

I found that the right eye presented no choroidal reflex with the mirror and had merely light perception. Movements of the eyes and muscular balance normal. The left eye had vision of *20/20* and had very extensive dust opacities in the vitreous. I gave the patient a prognosis of one chance in ten for recovery, and treated him with a direct current, the negative electrode being applied to the lids and the positive to the nucha. Beginning with a current of three milliamperes, and increasing it to seven on the third day, I repeated this daily for twenty minutes. After the third treatment, he was surprised to be able to see his wife, who was sitting near him; and, after the sixth visit, he could count my fingers at a foot in three-quarters of the field.

The vision steadily improved weekly, and, in a month, it was *20/40*. He then complained of diplopia. This was due to an acquired diverging strabismus. He was assured that if good vision should be restored he would then have binocular single vision.

Vision *was restored to normal* in three months. There was then no strabismus or diplopia and the convergence power was twelve meter angles.

Five years subsequently, his condition remained the same.

Case *2*. Miss M. B., has frequent recurrences of intra-ocular hemorrhage in the left eye.

The first attack occurred six years ago and prevented her seeing the form of objects. Under iodide of potassium, vision returned in six weeks to nearly 20/20.

Relapse a year later. With potassium iodide, sight returned in three months.

The third attack came a year later. She took calcium sulphide for six months with recovery of one-half vision.

A fourth attack later, when she could only see a candle flame. A fifth attack, later, and since then, vision has improved up to the present.

R. Eye,—Two years ago it had its first hemorrhage. Vision was very good in two weeks.

Relapse a year later. A third attack after six months.

A fourth soon after the third, but slight.

History,—Family history negative.

The patient never had any hemorrhage except ocular.

Present State,—Pulse 84. Anaemic. Blood pressure 132, normal. Bowels moved only by cathartics previous to the electrical treatment.

Vision R. E. = 20/20. L. E. = 20/200.

Liver and spleen normal size.

Previous Treatment,—After the fifth attack of the left eye, she took iron for a year, had the static breeze (general) and vacuum electrodes to brow and liver during the past year, and galvanism 1 and ½ m. a. with the positive pole to the lids for one month past.

EXAMINATION OF THE BLOOD.—(DR. HARROWER.)

Small Lymphocytes	40.6%	(22—25 normal)
Large Lymphocytes	7.3%	(3— 6 normal)

Pathological Elements, Myelocytes, 4.6%.

Red cells	4,300,000.
White cells	8,000.
Haemoglobin	90.

EXAMINATION OF URINE.

Reaction	65° alkaline.	
Urea	.011 gm. in 1cc	(normal 30 gm.)

Pus cells=many.
Casts =many .hyaline.

Treatment,—Continue the static breeze and increase the direct current to four to five m. a. with the negative electrode to the lids and the positive to the nape of the neck, for ten to fifteen minutes daily. This to be applied by an Electrotherapeutist in Winnipeg, her home city.

October *18, 1909.* The patient writes: "I am feeling much better, my eyes rarely ache. The left eye is clearing slowly but steadily. The field of vision is twice as clear. Am still under electrical treatment."

Leprince reports having treated a case of profuse hemorrhage of the vitreous with the *x*-ray, with marked success.

Ziegler cities a case of macular hemorrhage, which had been treated with drugs for three months without improvement, the vision continuing at *20/200.* The patient then came under his care. In one month, under positive galvanism, vision rose to *20/30.*

ACUTE HYALITIS.

Abadie reports a case of a man, in whom the vitreous of each eye was disorganized from intraocular hemorrhage, which had lasted for eighteen months. He had only light perception. Abadie penetrated the left eye with a positive needle for eight millimeters, for five minutes, using three to four m. a. of current. The patient counted fingers next day. After one month, he could readily read the house numbers. The right eye remained with only light perception.

Hirschberg Small Magnet.

CHAPTER VI.

THE DIAGNOSIS OF A FOREIGN BODY IN THE EYE AND MAGNET OPERATIONS.

After getting the history of the case and examining the exterior of the eye, the ophthalmoscope should be used: Then, the field of vision should be taken to determine whether there is any obscure area. Next, apply the tip of the magnet to various parts of the eye. If pain results, it is a positive indication of the presence of a magnetizable body—steel or iron—within the eye. The absence of pain is not conclusive evidence that no foreign body is present, for it may be too remote or too firmly embedded to move.

In regard to the question of securing a skiagraph, prior to the attempt to extract the foreign body by magnet, it depends, in my opinion, upon the method of operation to be adopted. If the magnet is to be applied to the centre of the cornea, the distance of the foreign body from the magnet will be about the same wherever it is situated—hence, the determination of its presence and position may be postponed. If the extraction is to be made through the sclera, I prefer to have the skiagraph taken previous to the operation; as it is best to determine the site of the foreign body, in order to apply the magnet near it, rather than to make an ineffectual attempt to draw it across the vertical or horizontal diameter of the eye.

In writing on the subject of Magnet Operations for Foreign Bodies in the Eye, William A. Fisher of Chicago says:—"I believe that the *giant* magnet is quite as convenient as the small for removing metal from the anterior chamber."

Regarding the question,—Should a skiagraph be taken before an attempt is made to extract a foreign body?

Fisher further says:—"An *x*-ray picture only causes delay, which favors infection. Use the magnet with a negative result in a recent injury, and, if later, the foreign body is located with the *x*-ray, what more can be done? A negative picture, after an unsuccessful operation, gives us double assurance that a foreign body is not present. In short, I believe that the *x*-ray work should be limited to old cases; and, to those in which a magnet operation has been unsuccessful."

Method of Operating.—Fisher writes,—"When a foreign body is suspected and the lens has become opaque, apply the tip of the magnet to the centre of the cocainized cornea; increase the current slowly to full force—unless the body appears with a current of less intensity. If it does appear, turn the current off, and place the tip at the edge of the cornea, and turn on the current. If the iris bulges, change the position of the magnet to make the metal pass through the pupil. Apply the magnet to an incision in the cornea until the metal adheres to the magnet, when the operation is finished.

If the body does not appear on the second application, turn on the full current, and make and break it several times to dislodge the foreign body. If the metal has entered the eye back of the lens, some operators prefer an opening in the sclera and removal at that point. I am of the opinion that all bodies should be extracted through the anterior chamber, although a foreign body that has entered back of the lens suggests removal through the enlarged original wound. The speculum and forceps and scleral retractors must be non-magnetic.''

The following table represents the results of Fisher's and Haab's magnet cases:—

HAAB—165 EYES.	
Failures	23
Splinters extracted	141
Enucleations	9 3
Sightless ball saved	19
Requiring Cataract Operations	71
Useful vision in these	51

FISHER—150 EYES.	
Symptoms of metal in eye but negative with mag't.	49
Metal removed	97
Metal found in ball after enucleation (magnet negative)	4
Good vision	96
Sightless	34
Enucleations	20

Kipp relates a case, as I remember, in which the magnet entangled the metal in the iris, and, by reversing the polarity, he claims, the metal was repelled and dislodged. This was probably accidental. While a long piece of magnetized metal may be repelled by changing the polarity of the magnet which has attracted it, a shapeless metal particle, when magnetized, has no definite polarity; and, when either the positive or negative pole is presented, it induces an opposite polarity in the metal and *attracts it.* This can be readily shown by presenting either pole of a small permanent magnet to a tack, and rapidly reversing the magnet.

Knapp, of New York, writes:—"If there is no pain, indicating the impact of the foreign body against the ocular wall, reverse (interrupt?) the current now and then, and move the eye in different directions, for, in ten minutes, the foreign body will have followed the attraction of the magnet. If the foreign body has entered the sclero-corneal border, apply the tip directly to the wound. The body will, in many cases, be drawn by the magnet on the cornea to the posterior surface of the lens, perforate the zonule, where it will be known by a bulge. Then try to draw it through the dilated pupil, by holding the magnet obliquely. If the foreign body enters the iris, we would have to extract the foreign body together with the iris; or, after an iridectomy. Authors, including Haab, seem to prefer drawing the foreign body from the vitreous into the anterior chamber.''

Knapp reports a case, in which, a foreign body removed through a scleral wound, was followed by a detachment of the retina.

Dr. W. A. Fisher, in a personal communication of December, *1912*, writes: — ''If a piece of steel could be brought into the anterior chamber, around the lens, in the human eye as nicely as it can be done in a pig's eye, then there would seem to be no use of extracting the lens other than through the cornea, especially when the lens is not opaque. In other words, if I had a piece of steel in an eye, today, that I could see with the opthalmoscope, and had my choice of taking it out through the sclera, or trying to get at it through the cornea, knowing that I would be very likely to injure the lens, I feel that I would prefer taking it out through the cornea, at the expense of losing the lens. I have always felt that a piece of steel taken out through the cornea, if the eye is not infected, would leave a man in the same condition as after a cataract operation. If the same piece of steel were taken out through the sclera, I have always had the fear of detached retina.

In a case in which the steel has been in so long that infection need not be suspected, there is no reason why an *x*-ray picture should not be taken, but, in a recent case, the danger of infection is so great that I prefer to remove the piece of steel without losing this time. No matter in what part of the eye the steel is located, I would place the tip of my magnet opposite the centre of the dilated pupil, and the steel would come forward, and, if through the pupil, I would see it in the anterior chamber. If it were lodged just back of the iris, I would see the iris bulging, and would, instantly, throw off the current and change the position of my magnet so as to draw the steel into the anterior chamber."

In reference to the site at which a foreign bod should be removed from the eye, the consensus of opinion favors the cornea, in those cases in which the body has entered through the cornea into the vitreous,—and, with this view, I am completely in accord. For the foreign body frequently produces a traumatic cataract, which has to be dealt with in any case. Notwithstanding the contrary view of Fisher and Haab, with their large experience, I prefer, when the wound is in the sclera, to extract the body at the *site of the injury*, rather than take the risk of producing a cataract or entangling the foreign body in the iris—results which have been frequently reported to follow the anterior method.

In experimenting on pig's eyes, I have found that iron particles could be readily drawn across the diameter of the vitreous through a scleral wound, when they could not be drawn from the vitreous into the anterior chamber. Dr. Fisher's remarks, regarding the ease with which a foreign body is removed from the vitreous by the anterior method, apply to the use, in his experiments, of *fresh* pig's eyes, while my experiments were made upon eyes somewhat hardened with formalin. This probably accounts for the difficulty experienced in removing the foreign body through the cornea; but, my contention remains, that, in a given case, the foreign body was removed, comparatively, more readily through the sclera than through the anterior chamber.

In reference to the detachment of the retina, by the posterior method, it would seem more reasonable to expect, from the direction of the force, that the detachment of the retina would follow the *entrance* of the body into the eye rather than its extraction.

In using the magnet, it is safest to control the current with a rheostat, lest a sudden dislodgement of the foreign body might be undesirable.

In one case, in which I applied the large magnet to the scleral wound without immediate success, I applied to the large magnet one end of the tip of a small permanent Gruening magnet (devised at least thirty-two years ago) and inserted the other end of the tip just within the sclera,—when the foreign body was immediately extracted and the case ended very successfully with excellent vision.

These extra tips have the advantage of being easily introduced through the sclera, and of being readily moved in different directions without the necessity of moving the whole magnet.

Similar tips were subsequently made in Germany for use with the giant magnet.

Dr. Albert Rufus Baker, of Cleveland, writing of "The Use of The Electro-Magnet and X-Ray" in removing foreign bodies from the eye, reports twenty-two cases. Speaking of cases *7* and *8*, both of which resulted disastrously, he says,—It is probable that in both cases the eyes were infected so that nothing could have prevented the panophthalmitis, and yet I have had this occur so much more frequently after the use of the large magnet than with the small one that I am constrained to believe that the dragging of the foreign body through the entire length of the eyeball with the large magnet opens up a new source of infection that may be escaped if the foreign body is removed through the sclera, near where it is lodged. I do not wish to be misunderstood as condemning the use of the large magnet in all cases, because I think in many cases of recent injury, when the patient is seen within a few hours, that it is better to remove the foreign body at once through the original wound, not waiting to have an *x*-ray examination made, especially if valuable time is lost in making the examination. Of course, in a case like the following, in which the foreign body could be located with the opthalmoscope, there should be no occasion for an *x*-ray examination.

Dr. Baker adds,—If I had a piece of steel in my own eye, I should prefer to take my chances in waiting a little longer and having the foreign body accurately located either with the ophthalmoscope or the *x*-ray before having an effort made to remove it.

Dr. Sweet has published an interesting paper on the magnetic properties of steel alloyed with other metals. His investigations showed that, with the exception of manganese steel, the magnetic induction of steel is only slightly affected by the addition of the steel hardening metals. In the higher percentage of nickel steel, some difficulty would be experienced in the removal of a splinter of metal from the eye, particularly if the body were covered with exudation.

Dr. Baker offers the following conclusions:—

1. I believe with Hirschberg that nothing but the early extraction of the splinter can prevent blindness when the foreign body is retained in the vitreous or retina.

2. Both the large and small magnets have advantages, and it is desirable for the ophthalmic surgeon to have access to both. I believe the tendency of the future will be to replace the so-called giant magnets now in use with the medium-sized ones, similar but somewhat larger and stronger than Sweet's, which are more easily handled, and if properly constructed will, in my opinion, do all that can be done with the larger ones.

3. As to the sideroscope, I was never able to secure one that proved satisfactory, and since I have been using the *x*-ray I have discarded it altogether.

4. If I could have the immediate services of a skilled operator, I should have *x*-ray photographs made of all cases in which the foreign body can not be seen with the ophthalmoscope. In recent cases, that would entail the loss of even a few hours, I am not sure but that many times it is best to remove the foreign body at once through the anterior chamber or through the tract of the original wound with the large magnet, and yet I must confess that in many such cases I have been disappointed in the results.

5. Contrary to the teachings of the text-books and my early instructors, I have had more and better recoveries when penetrating the sclera, even though involving the ciliary region, than when through the cornea, iris, and lens.

On the whole, I may say of the patients who come to me with foreign bodies in the posterior half of the eyeball, most of them are old injuries, that is from a few days to several months, that if I should retain any vision in *50* per cent. and preserve a cosmetically good eyeball so as to avoid wearing an artificial eye in *25* per cent. more, I should be as approximately near the truth as I could estimate.

Professor Schmidt-Rimpler (Halle) reports *92* per cent. of positive results in the removal of foreign bodies from the eye with the Haab magnet, in thirty-eight cases seen in the clinic at Halle. He prefers the large Haab magnet to the smaller Hirschberg magnet, except when the foreign body is in the anterior chamber. When it is embedded in the iris tissue, the force of the large magnet may be so great as to pull the iris out with the foreign body. He has seen this occur three times, and in one case the eye had to be enucleated. He therefore uses the Hirschberg magnet, especially the newer model, which is stronger than the old forms, when the particle is behind the iris, or in the anterior chamber.

If a scleral wound is still open, the body should be extracted through this.

Dr. Gordon G. Burdick, of Chicago, offers some very interesting suggestions on this subject,—"There are, he says, two methods that are fairly reliable in detecting the presence of a metallic body in the eye,—the movable magnet and the *x*-ray. If we suspend a very fine, long, magnetized needle with a very fine silk fibre and approach the eye to this needle carefully, the needle will be found to rotate towards the particle, if it is iron or steel. If we approach the other end of the needle, it will recede, and, eventually, turn round to point its north pole towards the metal. By approaching the suspended needle in different directions, we shall find a place where it moves quickly and points to a place in the eyeball the nearest to the foreign body.

This test is valuable as of negative value, and helps to confirm a failure of the *x*-ray to show a foreign body as being present.

One case illustrates this perfectly. I made three plates at different angles but failed to locate anything that looked like a foreign body. The needle test showed one to be present and I made the fourth exposure at an unusual angle and it showed the body plainly."

The Grossman method of localization is also of value. A small piece of fuse wire is fastened over the closed lids opposite the pupil, with a gelatine plaster. The patient is laid on the table with a proper support for the head; a plate placed under the part, and the patient directed to look down during one-half of the exposure, and then upward during the rest. This gives us two images of the foreign body upon the plate and the distance they are apart gives the approximate depth of the body. With careful attention to details, it is remarkably accurate.

THE LOCALIZING IN THE EYE OF FOREIGN BODIES OTHER THAN STEEL OR IRON.

Occasionally, says Dr. Burdick, we are called upon to find other bodies than steel or iron, many eyes being injured by glass or cement, and many eye surgeons do not know it is frequently possible to locate these bodies as well as steel. Where we are called upon to do this work, we replace our localizer with a particle of glass or cement from the same source as the original particle was derived, and by regulating the vacuum carefully we generally succeed in showing the foreign bodies without much trouble. The density of the shadow given by the localizer gives us a guide to read our plate.

DOUBLE PERFORATION OF THE EYEBALL BY IRON AND STEEL.

Dr. W. M. Sweet, of Philadelphia, reports twenty-two cases, and adds "Of the thirteen cases, in which the metal passed completely through the eyeball into the orbit, the globe was lost in five instances; in two,—because of panophthalmitis, in one from iridocyclitis; in one from collapse of the ball following an attempt to extract the metal; and in one in which extraction failed.

It is unnecessary to dwell upon the importance of *x*-ray examination in every instance of ocular injury from foreign bodies. In no other way is it possible for the surgeon, at the time of the injury, to determine that posterior perforation of the posterior scleral wall has occurred. Foreign bodies that lodge in the orbit usually cause no ocular symptoms. Disturbance is more likely to arise from bodies that are situated close to the posterior scleral wall, in the region of the ciliary nerves.

The importance, however, of keeping under observation for a considerable period all cases of foreign bodies lodged in the orbit back of the eyeball is shown in the history of case *19*. The acute inflammation following the injury subsided, but returned after a period of three months, and was associated with irido-cyclitis that compelled the removal of the eyeball."

W. Lang cites two cases illustrating the value of the *x*-ray examination in instances of old injury to the eye, with defect of vision.

In the first case, the patient consulted him regarding failure of vision, amounting almost to total amblyopia. There was a small corneal scar, with corresponding openings in the iris and lens. Though there was no history of injury, a skiagraph revealed a foreign body in the lowest part of the vitreous.

The second patient had a recent wound of the cornea, iris and vitreous, but no foreign body could be seen. This was subsequently located in the sclerotic at the fundus.

MAGNET OPERATIONS.

L. P. W., aged *20*, an engineer, consulted me December *13/05*. A week previously, while hammering a piece of soft iron into a piece of brass, a chip struck him in the left eye.

Present State,—Corneal wound to margin and cornea is hazy. The pupil resembles an external iridectomy. There is a glistening spot in upper end of wound.

Opacity of the lens prevents view of fundus; oblique light shows a dark object in centre of the lens. Pain is very slight. The giant magnet in contact with the eye does not produce any pain. Vision is equal to the motion of the hand..

Dec. *14*,—There has been severe pain during the night; the lens is more swelled.

The skiagraph shows a foreign body one and three-eighths inches behind the base of the crest of the nose.

Dec. *18*,—I removed a foreign body from the upper end of the corneal wound, after entering the chamber with a Graefe knife to support it.

Dec. *19*,—Field for candle absent from *90*° to *135*° up and in. Field only for *90*° to temporal side below the horizontal line; that is the foreign body and hemorrhage present, down and out.

Dec. *26*, — Enucleation. The foreign body proved to be Babbit metal, which is non-magnetizable. It was *4* × *5* m. m. in size.

Foreign Body in the Anterior Chamber.—Hirschberg reports several cases of removal of a foreign body.

1. A workman had received a piece of steel two m. m. long in the left eye. It could not be seized with forceps. Its posterior extremity was in the anterior chamber. Incision of the cornea over the foreign body, and the application of the magnet removed the offender. Recovery was complete with slight albugo.

2. —, aged *26*. Eight days previously, a piece of iron had entered the left eye.

Operation,—The cornea was incised and an attempt made to seize the foreign body with the forceps. The metal could not be removed with the forceps. Then the electric magnet was introduced and withdrew the metal. Recovery was without incident.

Foreign Bodies in the Iris.—A foreign body in the iris, above all when it is small, will be very often extracted with an incision of a portion of the iris, in which it is embedded; but with the view of avoiding an iridectomy, or when the size of the foreign body renders the result of the operation doubtful, we have recourse to the magnet.

3. Hirschberg reports,—A man hammering steel, received on February *29/82*, metallic particles in his right eye. On March *2*, the eye was much inflamed and vision reduced to *1/20*, with slight hypopion.

In the pupillary border of the iris, is a piece of steel, *5* m. m. long. The lens is clear.

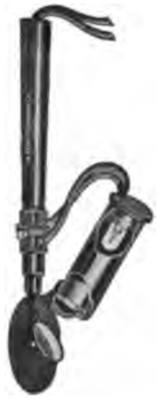
I operated three days after the accident. The cornea was incised at the margin and the magnet introduced. This attracted the foreign body. A small piece of prolapsed iris was excised. The recovery was rapid. The metal was *5* × *1* m. m.

In two analogous cases, Rothmund and McHerdy used the large magnet and the capsule was injured by the foreign body and cataract followed. Hirschberg has replaced the large magnet by his own small model.

Foreign Body in the Lens.—Hirschberg cites the following,—A man received an injury and presented a small foreign body at the periphery of the iris.

I magnetized the point of a cataract knife with the point of the magnet and punctured the cornea at the peripheral border and directed the point to the foreign body and extracted it with the magnet and then removed the crystalline masses and obtained an excellent visual result.

In an analogous case, Hirschberg left the crystalline masses in the eye to be absorbed. Intense irido-cyclitis followed; the masses were extracted, leaving a pupillary exudate and a doubtful possibility of obtaining a clear pupil.



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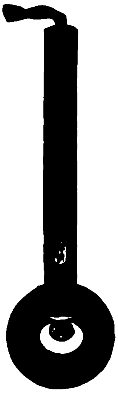

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De Zeng Electric Rectinoscopes.

CHAPTER VII.

DISEASES OF THE RETINA.

Retinitis Pigmentosa.—When we consider the pathology of advanced retinitis pigmentosa,—the retina atrophied and infiltrated with pigment, and the vessels sclerosed and narrowed, it is not remarkable that so many authors leave the subject of treatment without notice or briefly dismiss it in such despairing terms, as,—to assert that treatment is unavailing and powerless to check the progress of the disease, which almost always terminates in blindness.

Mayer remarks that iodine, iron, mercury, cod-liver oil, local blood-letting and collyria of atropine and calabar have all been tried with negative results.

Again electricity comes to the rescue and offers at least sufficient improvement to warrant every oculist giving it a trial before judging a case irremediable.

The following are illustrative of the cases which have come under my own care.—

Case *1.* Mrs. —, aged *28*, teacher. Vision failing for six months, especially at dusk; R. and L. V. *20/40*; fields at *1.* foot *6* inches in diameter. Color vision normal within above field. Retinae grayish at nasal side of discs. No pigmentation. Retinitis pigmentosa *without pigment.*

After twenty-one daily treatments for three minutes of galvanism to the eyes, vision rose to *nor-*

mal in each eye. Six weeks later she wrote, "My eyes are a great deal better in the darkness than before the treatment. There is now no aching in my eyes when I read."

Case *2*. W. W., aged *23*. The patient has hemeralopia; Photophobia is very troublesome in daylight.

Vision, R. E. = *20/200*. L. E. = *20/100*.

A lengthened treatment with galvanism very much relieved the photophobia, as is usual, but central vision and night blindness were not improved.

Case *3*. Mrs. —, aged *34*. With night blindness and *15/20* of vision in each eye. Reported ten months later that the galvanism advised had improved her eyes.

Case *4*. Dr. —, aged *48*. Night blindness since childhood, and vision steadily failing. R. E. = *20/80*. L. E. = *20/80*.

Sinusoidal current, twenty minutes to the eye daily for four weeks. R. E. = *20/40*. L E. = *20/80*. The pain in the eyes was relieved.

De Wecker recommends as beneficial,—hypodermic injections of strychnia, combined with galvanism daily for a period of three months.

Gunn remarks,—"I am looking up the literature of the subject. I find that galvanism has been tried by several authorities, but encouraging results have been reported by Neftel and Dor."

Dor treated a patient who had been unable to read or walk alone in the street. After a continued use of galvanism, he could walk alone and read for several hours daily. He also cites three cases, in all of which there was considerable improvement in central vision.

L. Webster Fox has treated a number of cases of retinitis pigmentosa successfully with the direct current and says that if there is no increase of the field after three treatments, no improvement is to be expected.

Miles Standish, of Boston, contributes the following case,—

—, aged *33*. Sight failing for three years. R. E. = *12/40*. L. E. = *12/50*. Fields *20*°. Galvanism to eyes once in five days for fifteen months. R. E. = *12/30* L. E. = *12/40*. Fields *70*°. The patient can now go alone on the streets after dark safely.

Marcus Gunn, of London, cites the following cases of retinitis pigmentosa,—improved with galvanism,—

1. Aged *42*. Losing sight for eight years; R. E. = fingers at three feet; L E. = *20/70*. Electricity and potassium iodide for six months. Vision raised. R. E. = *20/70* L. E. = *20/40*.

2. Aged *33*. Sight never good. R. or L. = Jaeger *4*. Galvanism three minutes daily for six weeks. R. E. = Jaeger *1*. readily. L. = J. *1*. barely.

3. Aged *20*. Retinitis for three years. Galvanism. Vision in right eye increased from *20/70* to *20/40*; in left, from *20/40* to *20/30*, and fields from *10*° to *25*°.

4. Aged *22*. Has had night blindness since three years of age. Vision in each eye = *20/40* and field *15*°; has been repeatedly treated by medication without benefit.

Galvanism ten minutes daily for a month leaves central vision unchanged, fields slightly improved. A month later,—"My sight is slowly getting better."

Haskett Derby, of Boston, has reported improvement in some cases under galvanism.

Little, in one case, observed improvement, under *faradism,* which continued for two years.

Leprince mentions a case of retinitis pigmentosa which he treated with *x*-ray. P., aged *22*. Retinitis pigmentosa in each eye. Vision R. or L.

= *0.2*. After three irradiations, each eye improved to *0.3* and the field increased *10°*. Patient continues treatment.

The following, I consider, is the most phenomenal recovery from retinitis pigmentosa on record, seeming almost incredible. It occurred under the application of the *500* c. p. lamp.

H., aged *41*, machinist, consulted Dr. J. E. Harper, of Chicago, who confirmed the diagnosis of retinitis pigmentosa. Vision had been impaired for twenty-four years and steadily grew worse up to three years ago. He had to be led about the streets. Vision *20/200*.

The case was referred to Dr. Rogers, who applied the *500* c. p. lamp, daily, for six weeks and then referred him back to Dr. Harper, who wrote, "I find Mr. H. sees letters to be read at twenty feet when he sits at eighteen feet." The patient has since been working at his trade.

Dr. Harper, in telling me of this case, said he might have doubted his first record of *20/200*, had not an attendant of the patient confirmed it.

Erythropsia.—Dr. Reuss has treated three cases of erythropsia by faradization, with complete success.

There were four attacks, in */86*, */02*, */04*, */07*. The patient recovered from each relapse after one treatment.

Detachment of the Retina.—

Mrs. S., aged *26*, consulted me November *3/07*. O. S.—*6.50* at *120°* = *20/40*.

Nov. *30/08*. On the *28*th inst., Mrs. S. noticed that her sight failed in the left eye so that she could only see her hand on the left side. The temporal half of the retina is detached.

℞. Double cautery puncture of sclera above and below external rectus. Dionin, and atropin, pilocarpin, bandage, hot compresses and bed.

Dec. 1st. Patient can count the rods at the foot of the bed. "Can see nearly as well as ever." Retina is reattached.

Feb. 1st. Retina reattached on temporal side, but there is a large detachment above. ℞. Two cautery punctures above.

Feb. 12. No detachment. Large floating opacities in the vitreous.

April 22/09. Vision = seeing fingers at 8 feet. Numerous opacities in the vitreous. ℞. Galvanism, five m. a. for fifteen minutes daily to eye.

July 12/09. L. + 2.50 = 5/70. Oct. 10/10. Detachment.

Sept. 15 /11. Cataract. Vision = light perception.

The advantages of the electro-cautery over incisions are,—that the wound remains open for a considerable time, allowing drainage; and, usually, one cauterization is sufficient,—while, with a knife puncture, the wound rapidly closes and the operation has often to be repeated a great number of times.

De Grandmont, Abadie and Terson have employed electrolysis in detachment of the retina. The current employed is five m. a. during one minute or two to three m. a. for five minutes.

The results were as follows,—In twelve cases of detachment, one existed for five years, the remaining from two to eight weeks. Eight operations produced temporary ameliorations and five more permanent, in which, two, after a second intervention were able to get about in daylight; but a certain degree of attachment remained. The ninth operation produced a painful irido-choroiditis. A third case of eight days standing was remarkably successful, as the eye had been practically lost.

In extensive detachments, Terson makes two punctures a little distance apart, with a positive needle.

Terson reports a temporary improvement in most cases and a permanent cure in recent cases, by perforating the sclera with the positive needle, giving five m. a. for one minute. It coagulates the fluid.

In one case, I increased vision for a time by positive galvanic needle puncture with one m. a. for one minute.

Stillson, of Indianapolis, treated four cases out of five successfully with the galvano-cautery puncture. There is no less irritable proceedure possible, he says. One puncture is made under the most prominent part of the detachment and the second near the margin. The cautery is held for a moment until it burns a round hole. The rent remains open for six to ten weeks. The after treatment consists of rest in bed, with the eye bandaged and the usual medical treatment.

Case *1.* —, aged *40.* Almost complete detachment for three years. Blind. One puncture was made at the external canthus and one at the internal. In four weeks vision was *20/80.* No relapse in three years.

Case *2.* —, A nearly blind eye for ten months, with a detachment of lower half. Four weeks' medication gave little improvement. Two lower punctures were made. In five weeks, the retina returned to place and the eye, after two years, retains vision of *20/100.*

Case *3.* —, aged *46.* Vision failed for six months, with detachment of outer lower quadrant and inability to count fingers at one meter. A puncture was made above the external rectus and another below, and a third at the end of three weeks. The retina all went back and *20/90* of vision has continued for a year.

Case *4.* Two years ago a blow on the head was followed by retinal hemorrhage and detachment. A negative result followed two punctures.

Case *5*. —, aged *36*. Sudden blindness and detachment of the lower half followed exhaustive vigils. After two punctures, one remained open five weeks and the retina returned to place. Five weeks later there was *20/70* of vision which was the same at the end of a year.

In some cases, Abadie punctured the sclerotic and the choroid with the galvano-cautery. The subretinal fluid escaped and an adhesive inflammation was produced which maintained the retina in place.

In cases of extended detachment, there was only one temporary amelioration, but in two other cases with limited detachment, there was a satisfactory and permanent result.

Retinal Hemorrhages.—June *3/08*. C. D., aged *58*, has not seen the upper part of objects for two weeks.

R. E. vision with correction, = *20/70*. L. E. = *20/20*.

Right Fundus.—Scattered stellate hemorrhages in retina around the macula and upper part of fundus. White spots of degeneration in macular region. Urine normal. Blood pressure *140*, normal.

Treatment,—Potassium iodide and ung. hydrarg.

June *29*. Vision R. E. = *20/70*.

℞. Discontinue medication. Apply negative galvanism to the lids for twenty minutes daily.

July *28*. Less hemorrhage. "Objects appear less foggy." Vision R. E. *20/50*.

In a case of hemorrhagic retinitis, which had been under general treatment for a year without effect, Erb applied one to one and a half m. a. of galvanism to the eyes .for five minutes daily. In three weeks, there was a happy result.

Diabetic Retinitis.—By the application of *2* m. a. of negative galvanism to the lids, two to three times weekly, Alleman secured the absorption of old hemorrhages and prevented new ones.

Diagnosis of Cysticerus of the Retina.—Galvanism and faradism have been employed by Vincentiis in the diagnosis of cysticercus of the retina. The electrodes were applied to the temple, and, at the moment of the interruption of the current, the ophthalmoscope demonstrated the contraction of the semi-transparent masses of the cysticercus.

In *1881*, Abadie tried to evacuate the subretinal fluid and operate upon the detachment of the retina by electrolytic puncture. He had several satisfactory results.

He made one puncture at the centre of the detachment and penetrated about two m. m. with a current of two to three m. a. for five minutes and applied a bandage.

Gillet de Grandmont and Terson have obtained with Abadie's method complete recoveries. I cite one case from de Grandmont,—

A patient with high myopia (progressive) with retinal detachment for forty-eight hours. Made a puncture with the needle, with a current of five m. a. for one minute. This was repeated four days later. After the second seance, the detachment disappeared. Before detachment, the vision = light perception. After treatment the vision was one-third.

Darier has found electrolysis yields good results sometimes in detachment of the retina. The positive electrode knife of irido-platinum is passed into the sclera at the level of the detachment, with two m. a. of current for two to three minutes.

Retinal Thrombosis.—With recovery under the use of the Direct Current.

Aged *57*. Vision of right eye failed suddenly two months ago and the patient now sees fingers at fourteen inches in limited field. The infero-temporal area showed an opaque grey retina and the macula was cherry red. Negative galvanism was applied to the lids, with a current of five to seven m. a. for fifteen minutes daily. On the twelfth day vision had improved to *6/15* for the far point and to normal at twelve inches.

I find none but my own case of retinal thrombosis on record treated electrically.

Retinal Embolism.—The following case was referred by Dr. J. E. Harper, of Chicago, to Dr. Rogers for treatment.

Mr. W., aged *53*. Family history good; general health excellent. He woke one morning with impaired vision of left eye, and this increased until the sight of the eye was lost.

Dr. Rogers applied the *500* c. p. lamp for ten minutes, immediately after which, the eye improved so that he could distinguish people in the room. Treatments were continued twice daily, and, after eight days, he could distinguish people at twenty to thirty feet. He then removed from the city, but continued treatment, it is said, with uninterrupted success.

Neuro-Retinitis.—In cases of neuro-retinitis Leprince employs a continuous current, and succeeds in arresting degeneration. He uses five to fifteen m. a., with the negative pole to the eye and the positive in the hand. He maintains that this current has never injured the eye and that slight cases should be treated with weak currents and the graver cases with stronger currents in order to avoid optic atrophy; that the treatment should be daily or every second day, and continue for twenty minutes.

The treatment of optic atrophy, he claims, rests upon the same principles.

In essential atrophy of the optic nerve, Leprince has not produced a single recovery or even a complete arrest of the morbid process.

Retinitis Albuminurica.—April, /10. Mrs. A. Martin, aged 27. Extensive albuminuric retinitis. Many flammate hemorrhages border the retinal arteries. Six months ago she was examined by Dr. Eiss, and glasses were prescribed. Vision in right or left eye was then 20/20, and the urine was normal. Three months ago vision began to fail, and she is now very weak and has considerable albumen in the urine.

Vision R. E. = 20/66. L. E. = 20/100.

Prognosis,—Death in three to six months.

℞. High-frequency current with auto-condensation couch, twenty minutes tri-weekly.

May 3. Eats and sleeps much better and feels much stronger. Considerably less albumen in urine. Vision R. E. 20/40. L. E. = 5/100.

May 18. Yesterday, patient died in uremic convulsions.

Retinal Anaesthesia.—L. Webster Fox, who has made an extensive study of anaesthesia of the retina in children, writes that he finds this affection characterized by a reduction in the acuity of vision with no reversal of the color fields. There are, he says, no other symptoms and the eye-ground is normal. The affection is usually observed in children from six to fourteen years of age. The field is contracted from 30° to 35° in each meridian, and vision is reduced to one-fifth or less. The color fields are contracted proportionately.

The treatment consists of a constant electric current, "voltaic alternatives," of one to two m. a. daily, for ten minutes, with the negative electrode to the lids.

Recovery, Dr. Fox says, is prompt and he reports fifteen cases out of twenty-four under observation.—

Case 1. Vision, R. E. = 20/70. L. E. = 20/50.

Contracted fields. H = + .25 in each eye. Five treatments were given, after which, both vision and fields were normal.

There was no recurrence in seven years.

Case 4. Jan., /96. Aged 12.

Vision, R. or L. = 20/100 + 50 = 20/50.

Fields 10° in all meridians. After eight treatments, vision and fields were normal. In 1889 there was a slight recurrence.

Case 6. Feb. 25/99. Girl, aged 11.

Vision, R. or L. = 20/200. —.50 at 180° = 20/70. Fields 15°.

Five treatments give normal fields and vision. No recurrence.

Case 15. Nov., /02. Indian girl, aged 12.

R. + 25. = 20/100. L. + 25 = 20/40.

R. E. field = 30°. L. E. = 40°. Improvement followed seven applications.

The author remarks, "This is the only case among the red race I have ever found, having examined 3,500 children."

There were seven instances, in which the current was used alone, and the response was prompt as usual and there were no recurrences. Frequently, the correction accepted during the affection was rejected when the fields and vision were restored.

Hysteria, I think, may be excluded from the etiology. The color fields were not inverted, nor were there any of the ocular symptoms of hysteria.

The unusual term "voltaic alternatives" used by Dr. Fox, refers to a method of using the direct current, devised by Dr. G. Granville Faught, who thus describes it,—"After several years of experimenting, I affected a method of therapy, which I designated as 'voltaic alternatives,'—a term used to indicate sudden reversals in the polarity of the electrodes of a voltaic battery; and I devised a pole-changing handle. In ordinary usage, I reverse the current *30* times a minute."

While this method gave extremely satisfactory results, the apparatus is less familiar to the physician than the alternating current generator, and, in my opinion, the latter would prove equally effective.

Traumatic Anesthesia.—Pensier, of Paris, presents two cases of traumatic anesthesia of the retina.

Case *1.* M. A. received a blow on the head, which produced photopsies. On the third day, amaurosis and mydriasis were extreme. There were no indications of a central lesion. Two hypodermic strychnia injections were prescribed daily. Visual perception reappeared at the third injection. Strychnia was not tolerated on the twelfth day. Faradism was then begun.

On the twentieth day the patient read No. *12* J.

Complete recovery followed.

Case *2.* Struck on the eye with a stone. Vision = *1/4.*

Faradism was prescribed. The positive pole was moved to and fro on the lids. Recovery after three seances.

SYPHILITIC NEURO-RETINITIS,

Boucheron reports a case of syphilitic neuro-retinitis,—

M., aged *22*, came under his care December *3/73.*

The patient reads No. *7* Snellen near and No. *30* far.

℞. A feeble direct current to be applied tri-weekly.

March *26/75.* The patient now reads No. *2* near and No. *10* at ten feet.

Rogers says that the lamp should be applied locally and generally in syphilitic retinitis, the same as in syphilis. In the later stages, the patient is stripped and the rays of the *500* c. p. are passed over the whole body for thirty minutes. The rapid oxygenation of the blood destroys all toxic matter. In some instances, there is an increase of ten per cent. of red corpuscles and an increase of the white one hour after the treatment.

HEMORRHAGIC RETINITIS.

Arcolio reports the following case of hemorrhagic neuro-retinitis,—

J. K., aged *46*, in November, */73*, suddenly lost vision.

In December, */73*, he has double optic neuritis.

Purgatives, leeches and blisters were used without avail.

February *20/74*. Absolute blindness for two hours.

Small elements were used with the electrodes applied to the temples night and day.

April *2*. The patient is dismissed with the vision reestablished.

CHORIO-RETINITIS.

Boucheron cites a case of chorio-retinitis, as follows,—

J., aged *66*, has impaired vision. He has been treated with iodide of mercury without result.

April *1/95*. Vision R. E. = *1/20*. L. E. = light perception.

Chorio-retinitis and dense leucoma.

After twenty-five seances, of twenty minutes each, with a direct current of three m. a. the right eye has *2/5* and left *1/60* of vision. The leucoma has cleared considerably.

ATROPHIC CHORODITIS.

Boucheron reports the following case,—

P., fell against a pole, the accident producing a sclero-corneal rupture and a prolapse of the vitreous and iris. He is left with light perception only. An iridectomy is impossible. The wound was sutured with catgut; the lens luxated. Vision with glass = *2/5*.

Two months later, hemorrhage occurred within the vitreous, abolishing vision. Thirty seances with the direct current cleared the vitreous. Atrophic choroiditis was present.

January *1/94*, the current was repeated thirty times, after which the vision with glasses was *1/5*.

GLIOMA OF THE RETINA.

Hilgartner cites a case of double glioma, in a child of three and a half years.

The growth largely filled the right vitreous and was incipient in the left. Eighty-four *x*-ray exposures shrank the right growth to two-thirds of normal and completely absorbed the left.

Würdemann, of Milwaukee, reports a case of glioma of the orbit, maxillary sinus and nose, which was exenterated three times. X-rays were finally used for one year, with hindrance of development and absolute prevention of pain.

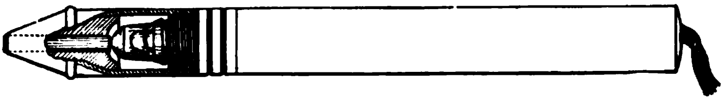


Fig. 104.—Wurdemann's Ocular Transilluminator.

Retinal Hemorrhage.—Dr. John E. Campbell, in a personal communication, submits the following case:

G. H. V., aged *33*, a clerk, consulted me in October *7*, *1906*, complaining of poor vision in the left eye for the past nine days. Vision R. E. = *6/6*. L. E. = *6/60*.

The ophthalmoscope showed central macular hemorrhage, with small clot. The resulting central scotoma troubles him much in his work.

He received galvanic treatment daily and in five days the vision was *6/18*, in one month *6/9*, with blood clot gone.

The vision one month later, was *6/6* full.

The negative pole was applied to the closed eye and the positive to the back of the neck, with a current from two and one-half m. a. for five minutes to ten m. a. for ten to fifteen minutes.

CHAPTER VIII.

THE OPTIC NERVE.

OPTIC ATROPHY.

Optic Atrophy is universally acknowledged by oculists as one of the most hopeless conditions with which they have to deal. The concensus of opinion is that it will be followed, as a rule, in two or three years by blindness.

Up to the present time, the text books, almost without exception, recommend that it should be treated with hypodermic injections of strychnia and the administration of phosphorus, tonics, etc.

Having followed this method of treatment faithfully for several years, without, to my knowledge, having improved the vision of a single case, I some years ago, treated a patient as above for four weeks, without benefit, and then tried the application of interrupted negative galvanism to the lids, daily for four weeks,—when vision had improved from *20/200* to *20/40*. Since that time, I have not treated a case medically. Until *1902*,I used galvanism; and, since that time, I have used the sinusoidal current exclusively and have very satisfactorily improved vision in sixty-six per cent. of my cases. At that time, I had not found any mention of the application of the sinusoidal current to the eyes; and nowhere, in literature, have I seen so high a per cent. of successes in the treatment of optic atrophy with this current.

(For a more complete exposition of the therapeutic effect of the sinusoidal current, see page *123*).

In *1906*, I reported the result of treating, with electricity only, twenty-three eyes having optic atrophy. Of these, two had only light perception. One improved and the other acquired *20/67* vision. Out of eighteen, in which there was form perception, sixty-four per cent. were improved. Four were improved sixty to one hundred and twenty-five per cent.; two,—thirty per cent.; three,—five hundred per cent.; one,—fifteen hundred per cent.; and two, that could only count fingers, acquired reading vision. Six did not improve.

A few of these cases will be cited to show that the most unpromising deserve a trial of treatment.

Case *1*. May, */83*, aged *10*. Optic Atrophy, following sunstroke. L. E. reads J. *16* on the temporal side. Strychnia, hypodermically, was administered daily for one month. Vision = J. *14*. After galvanism for one month, daily, applied to the lids, vision rose to J. *1*. This case terminated my trial of hypodermic strychnia, which I had used since *1870*, in doses of gr. *1/24* to gr. *1/4*, without consciously improving vision in a single case.

Case *2*. Aged *12*. Double atrophy, probably of cerebral origin. R. E. = light perception only. L. E. = *20/30*. Had severe headache and vomited about twice weekly. The child had been very delicate from the age of five to ten. The fields contracted. ℞. Application of the sinusoidal current, with an oval pad, two inches by three and a half, to nape of neck, and a binocular electrode, double the usual size to the lids for twenty minutes daily.

Six months later, vision was R. E. = *20/70*. L. E. = *20/20*.

Case *3*. Aged *61*. Double traumatic atrophy. In this case vision increased, in each eye, from seeing fingers at twelve inches to *6/18*.

The patient had been struck on the forehead three months previously, had been treated for three months at the Ills. Eye and Ear Infirmary, and had been discharged as incurable. Galvanism was applied for four months.

Case *4*. Aged *70*. Vision, which in left eye was *20/200*, increased to *20/67* after four months daily treatment with the alternating or sinusoidal current.

Miss —, aged *36*. Had had double primary atrophy. Six years before consulting me, she had been skilfully treated in an eye hospital for a year without any improvement in vision. The discs showed extremely advanced optic atrophy. There was complete loss of color vision. The fields of vision were slightly contracted but the size of the field was the only encouraging feature of her case. She could count fingers with uncertainty at from six to twelve inches only.

I could give her no encouragement to have treatment and advised her to go home. She consented to attend the Chicago Ophthalmological Society, where the members remarked that from the appearance of the papilla it was the most advanced case of optic atrophy they had seen, and that they considered improvement hopeless.

She, however, insisted upon having treatment and I applied the sinsuoidal current to her eyes, daily, for four months. After nine days treatment, she said she could read the headlines of the daily papers for the first time in six years. At the end of four months, she was able to select her own letters from the mail delivery and to attend to her correspondence.

At this time, her enthusiasm was boundless regarding the improvement in her vision, but after yielding to the solicitations of friends to attend a Christian Science service, she wrote me the following day that "she had concluded to leave her case in the hands of her Heavenly Father." Subsequently I heard that her sight was again failing.

January *15/07*. J. R., aged *6* months, has optic atrophy of both eyes. Nystagmus has been noticed for six weeks, and it has increased for two weeks past. The head moves constantly from side to side.

Treatment,—The sinusoidal current was applied to the eyes ten minutes, tri-weekly, (*5* volts).

September. No nystagmus or shaking of the head.

January *6/08*. Relapse three weeks ago. Referred to Dr. Vail of Cincinnati for treatment.

April *29/10*. G. M. L., aged *47*.

L. Eye.—Traumatic optic atrophy.

On December *26/09*, was pinned under a capsized auto. Was momentarily unconscious and his mind wandered for three or four days. There was concussion of the lower cervical region and the lids were blackened.

The vision of the left eye began to fail soon after the accident and he thinks the sight gained a little up to four weeks ago. Vision of left eye = *4/40* (by turning eye to left).

℞. Alternating current for twenty minutes daily with *30* volts to eyes.

May *19/10*. Patient says the vision of the right eye is now clear, while it was hazy in the mornings before treatment. The left eye is better; can now see signs which he could not see before he had treatment.

Unexpectedly, discontinued treatment.

November *5/06*. W. G. L., aged *43*. A year ago, the patient noticed that the vision in the left eye was poor.

Vision, L. E. = *1/200*. R. E. = *20/20*.

Left papilla is white with clear margin. Optic atrophy.

The patient had been previously treated by Dr. Barlow with Hg. I. and Aspirin.

℞. Referred to Dr. Barlow for treatment. with the alternating current to eyes for ten minutes daily.

Dec. *24*. Patient can now see electric light, which he could not, previously. At first he could see a flash during the treatment, then the interruptions of the current were made more rapid and no flash was perceived.

Central vision remains the same, *1/200*, but the field is fifty per cent. larger.

℞. Treatment tri-weekly.

January *24/07*. Vision L. E. *9/200*.

Subsequently, vision fell to *3/200*.

March *1/06*. Miss T., aged *36*. Uric Atrophy.

Vision R. E. = light. L. E. = *20/33*, not improved with glass.

Fundus, except the papilla, appears normal.

℞. Alternating current to both eyes daily.

March *1/06*. Miss T., aged *36*. Optic Atrophy. R. E. = light. L. E. = *20/20* +.

May *3*. Vision L. E. = *20/20* +.

September *26/06*. Miss F. A., aged *59*. Her eyes gave out three years ago after a death in the family. She could not bear the light, and her eyes were painful and red.

Present State,—The patient wears a handkerchief over her eyes. The conjunctiva is very red and velvety.

Vision, R. E. = *1/300*. L. E. = *1/200*.

There are large and numerous webbed opacities in the vitreous.

Shadow test shows,—Myopia *8.00* to *10.00* each eye.

Very broad atrophic crescent (choroidal) in right eye; moderate in the left; health, very nervous.

℞. Galvanism, negative, *5* m. a. to lids for ten minutes daily.

℞. High-frequency couch for five minutes daily.

October *22/06*. Vision R. E. = *1/100*. L. E. = *3/100*.

A case in which, from inability to see No. *200* close to face, vision is raised to *12/200*.

October *11/07*. Dr. R. D. H., aged *59*. Referred by Dr. Gifford, of Omaha. Optic atrophy was diagnosed six years ago. There is a great deal of pain in the top of the head. Polyuria. Rheumatoid Arthritis.

The right eye counts fingers at eight inches.

The left eye counts fingers at fourteen inches.

No. *200* cannot be seen close to face.

Previous Treatment, — For the past three months, strychnia up to gr *1/5* t. i. d. by the stomach, and K. I. grs. *5* t. i. d.

The vision grew worse up to two years ago and has not improved since.

℞. Application of the sinusoidal current to lids and neck for twenty minutes daily.

October *18*. "Can now see directly in front instead of eccentrically, by turning head to the left."

October *24*. Vision, right or left eye = Fingers at six feet.

October *27*. ℞. Change electrodes to temples and neck.

November *9*. ℞. Change electrodes to cervical sympathetic and eyes.

November *11*. Less light flash produced by the current, and the electrodes were applied to the eyes and nucha.

November *20*. Vision, right or left eye, = *8/200*.

Patient feels much encouraged, as he could not see the elephant in the park when he came, and, three weeks later, he could see the birds fly.

January *22/08*. Vision R. E. = *12/200*. L. E. = *12/200*.

The left field is gradually improving on the temporal side. Patient is obliged to return home.

The following case showed no improvement in sight after treatment with the sinusoidal current, the lamp and radiation.

March *19/10*. John B., aged *42*, was sent to me by Dr. G. T. Hogue, of Milwaukee, who says, "There is an optic atrophy of both eyes due to nicotine poisoning. Mr. B. has been a very heavy smoker for the past twenty-five years and also a very heavy drinker for the past twenty years. While he has been at the Sacred Heart Sanitarium, since October, *1909*, his improvement has been gradual but sure. He has not taken any tobacco or liqnor since going to the Sanitarium."

Both papillae show blue-white atrophy.

Mr. B. gives the following history,—His sight began to fail five years ago, decreased for two years, and then remained stationary for eighteen months. It again grew worse for six months, since when, it has remained the same.

Vision R. E. = *15/200*. L. E. = light perception.

Previous Treatment,—Three years ago, he was with Dr. Harper for three months without improvement.

Dr. Hogue applied the alternating current and massage to the eyes for ten minutes, daily, for six months, apparently without improvement in vision.

The pupils react to light slightly and are moderately dilated. In near fixation, the left eye diverges.

Treatment,—Apply an alternating current of *38* volts to the nape of the neck and eyes for fifteen minutes daily.

Three weeks later there is no improvement in vision or field.

The prognosis was unfavorable, as the alternating current did not produce light flashes.

The *500* c. p. lamp was next applied, six inches from the face, for ten to fifteen minutes daily, the patient intercepting the light with a fan, when too hot.

General electrification was given for ten minutes daily with the auto-condensation couch.

Vision was not increased in three weeks. Then *x*-ray flashes (*100* per minute) were given with a low tube, at a distance of six inches, for ten minutes daily for three weeks, without any favorable result in central vision, but with some increase in the field.

If the alternating current does not improve vision in optic atrophy, I do not expect that other agents will improve it, although it is advisable to try all our resources.

Würdemann, of Milwaukee, writing, in *1908*, of the treatment of partial optic and retinal atrophy by electricity and massage, reports that he used the rapid faradic current with the galvanic, and vibratory massage with the ear pump. He observed that the disk is reddened and the vision and field are improved immediately after treatment. Also, that the reddening is more pronounced after massage than after electricity. He uses a current of from five to ten milliamperes three to five minutes daily or tri-weekly during one to two years. He further adds, "I claim that partial primary optic nerve atrophy, that atrophy consecutive to optic neuritis and to chronic retinitis can be checked, the nutrition brought back to the nerve, the discs made to look more normal, the visual acuity and the fields greatly enlarged and the patient preserved as a useful member of society in the great majority of cases. But the diagnosis of primary atrophy or partial degeneration of the optic nerve fibers at the ocular end of the nerve must be assured before a favorable prognosis can be given. One surely can not theoretically expect any effect upon the visual tracts or centres from an oscillation of the eyeball, a stretching and vibration of the optic nerve, which cannot possibly extend further than the apex of the orbit. The same may be said of the local effects of electricity, for these are peripheral treatments.

I wish to state that here I distinctly differ with Dr. Würdemann. I believe that electrical vibrations, especially the sinusoidal, produce not only vascular stimulation, as does mechanical massage of the retina and disc, but also that they *do* stimulate the visual tracts and centres. The light flashes produced by the galvanic and sinusoidal currents, and the vertigo and even hemorrhage, caused by galvanism, are evidences of brain stimulation, which cannot be induced by mechanical vibration.

I also quote from an editorial in the Jour. A. M. A. of Jan., *1910*, "Before Leduc's work, it had been demonstrated by Erb, in *1867*, that electric currents could be made to pass into the brain-substance. Erb's work was done on the cadaver, the skull being opened and a small galvanometer placed within the brain; passage of the current invariably deflected the galvanometer. Fritsch and Hitzig later showed the regional excitability of the brain to the current, but it remained for Leduc to demonstrate in *1902* the possibility of the electric penetration of the intact cranial vault. He accomplished this result by means of a wheel interrupter so arranged that it delivered a series of successive shocks, each of one one-thousandth of a second duration a passive period intervening of nine one-thousandths of a second. In the lower animals he produced with this current an inhibition of the activities of the cerebral centers, leaving the respiratory and circulatory centers intact, thus causing a condition characterized by loss of voluntary movements and the presence of general anesthesia, to which he gave the name 'electric sleep.' "

And I would further add that the fact that the galvanic and the alternating currents produce light flashes is conclusive evidence that the stimulation produced by the current does reach the *optic centres.* For, if the stimulation of light or an electrical current reached only the intra-ocular end of the nerve and did not extend to the optic centre, there would be neither light perception, vision nor light flashes.

In corroboration of this, I cite the opinion of Gillet de Grandmont, who states that "electrical phosphenes depend upon the congestion of the cephalic centre of the optic nerve."

I exclude Würdemann's cases *5*, *6*, *8*, *9*, *11*, and *17*, as the combined use of drugs masks the electrical effects.

Case *1.* Aged *10.* Primary Atrophy, hydrocephalus; vision in right eye increased from *6/60* to *6/12*; in left eye from *6/36* to *6/18* by electricity and massage alone for *23* months.

Case *2.* Aged *19.* Post-papillitic atrophy; congenital lues; total blindness. Electricity and massage for eighteen months produced vision in right eye = *1/60.* In left eye = *1/20.*

Case *3.* Mrs. —, Secondary atrophy of nerve and retina from albuminuric retinitis of pregnancy.

Nov. *11/05.* Aged *29.* Patient had had iodine and she gradually lost vision. R. E. distinguishes movements of objects. L. E. = *6/12.*

Electricity, massage, iodides and strychnia at intervals, till May, */97*—eighteen months—when vision in right eye is *1/70.* Vision in left eye remains *6/12.*

Case *7.* Aged *47.* Post-papillitic syphilitic atrophy. Has had full treatment for two years and has grown rapidly worse in the past six months. Electricity, massage and regular treatments. After nine months, vision in right eye increased from fingers at one meter to *2/60*. In left eye from *3/60* to *5/60*.

Case *10*. Atrophy following thrombo-phlebitis.

Massage and electricity only. After three months, vision in right eye increased from *7/8* to *6/6*. In left from *6//36* to *6/24*.

Dr. Würdemann's third case offers such a rare and crucial opportunity of comparison between the results of treating optic atrophy with galvanism, faradism and massage combined; and treating it with the sinusoidal current only, that it is justifiable to report the further history of the case.

The patient, unimproved in the left eye by two year's treatment, consulted Dr. Black, who brought the case to me in consultation. I advised the application of the sinusoidal current *only* to the eyes and the nape of the neck, daily, for twenty minutes within the limits of tolerance.

The previous record had shown the vision of the left eye as *6/12* both at the beginning and close of treatment; of the right eye as increasing from hand movements to *1/70*.

Under the sinusoidal current, vision of right eye rose, in three months, to *6/7.50*; of left eye, to *1/30*.

Pensier reports the following case of optic atrophy,—

M., aged *58*. Eyes have been affected with ocular trouble for three years.

December *27/92*. Vision R. E. = *2/30*. L. E. = *2/10*.

Chronic chorio-retinitis and optic atrophy.

From January *15*, to June *1/93*, the patient had *48* seances, with a current of *4* m. a.

June *1*, vision in R. E. = *2/10*. L. E. *2/7*.

Since then, vision remains the same.

Dor says that the cases of progressive white atrophy, that formerly have seemed to constitute a "*nole me tangere,*" can be effectively combatted by electricity.

He reports ten cases of progressive atrophy, in which the current notably enlarged the field and increased the vision. The improvement persisted after one or several years. The treatment, he says, is long counted by months. Often the improvement is rapid but sometimes prolonged.

In monocular atrophy, Dorr places one electrode on the mastoid and the other on the lids of the same side. If both eyes are affected, he places the electrodes on the two temples.

Repeated Daily Applications of Electricity.—Weiss electrifies his patients five to six times daily for from fifteen to thirty minutes, changing the direction of the current every five to six minutes. He employs a current of *2* m. a., one elctrode being on the nucha, the other on the eyes. Weiss reports marked improvement in one grave tabetic case.

Gillet de Grandmont says that in incipient atrophy we can use the constant current with confidence. In all cases, electricity is absolutely harmless.

Dor, Boucheron, LeFort, Driver, Weiss, Gunn, Benedict, declare electrical treatment gives good results in diverse atrophies; tabetic, syphilitic, traumatic.

Boucheron says that the age of the patient is an important factor in success. In youth you can have hope.

Pensier states that he has not obtained any result in tabetic cases, but has had excellent success in optic atrophy of choroidal origin.

Boucheron recommends feeble currents prolonged or strong currents, say, *3* to *6* m. a., less prolonged.

Remarkably Good Results Obtained in Tabetic Atrophy By the Use of An Exceptionally Strong Current for Unusually Long Seances.—M. S. Zanoga says he considers that by the application of stronger currents for longer periods than were formerly in vogue, better results may be looked for.

He treated his patients with *10* m. a., commencing with half-hour treatments and increasing to one hour. One of his patients could scarcely see to move around his room. After ten treatments he could read the title and head lines of a newspaper and the improvement continued.

Driver relates that a patient, with optic atrophy, who had been variously treated unsuccessfully, could distinguish, with the right eye, fingers at four feet only; and, with the left, at three feet. After the use of galvanism to the eyes, for fourteen months, vision increased to reading Jaeger No. *8*.

Driver employs only the constant current in optic atrophy, as the faradic has never yielded any good results.

He reports the following case,—A patient, aged *45*, had R. vision of *20/50* increased to *20/20* in three weeks with galvanism. Six months later there was a relapse, when vision of *20/30* increased to *20/20* with galvanism in twelve days.

Dor concludes that forty to fifty per cent. of these cases may be notably improved.

Gunn, in eighteen cases, had good results in six, doubtful in four, and no improvement in eight with galvanism.

Erb says the results are a little more favorable in cases with no assignable cause. He observed the usual discrepancy between the visual improvement and persistent pallor of the disc. He says there are a few cases of optic atrophy associated with locomotor ataxia, in which a considerable improvement may be effected.

Erb reports the following case,—Patient with descending optic neuritis followed by atrophy and dorsal myelitis and complete paraplegia. Vision R. E. = *6/60*. L. E. = *6/100*.
Galvanism for four months resulted in vision right or left eye = *6/18*.

Darier writes,—"Electricity, applied to the optic nerves, or, rather, to the eyeball, has a suggestive rather than an actual effect, but it is always a good method, because it never does harm.

To both of these statements, I dissent. The proposition that optic atrophy is amenable to suggestion will be accepted by few real physicians. That the indiscriminate use of galvanism may do harm has come under my observation, in an instance in which an oculist allowed his patient to give herself home treatment,—which resulted in a serious choroiditis.

Wood Alcohol Blindness.—Fatal blindness from the toxic action of wood alcohol, with recovery of vision under electricity, is shown in the following cases of S. Lewis Ziegler.

There was total loss of vision for almost two months. The disc was atrophic. The continued improvement of vision and widening of the field, during the past eight months, show that the danger period of secondary shrinkage has been safely passed. There is increased hyperemia of the nerve head. Vision is now normal.

Ziegler cites two other cases of optic atrophy, one of which had *20/200* of vision stimulated, with negative galvanism up to *20/40*, which was retained years afterward.

The second was another case arising from the fumes of wood alcohol. The patient recovered practically normal fields and vision after a year of galvanism.

Vision in Optic Atrophy Markedly Improved With the X-Ray.—Coover, of Denver, submits three cases of optic atrophy treated with the *x*-ray,—the first complicated with nyastagmus.

Case *1*. Aged *28*. Received an injury to the head at two and one-half years of age, and, since then, has been blind. Has light perception only. There is divergent strabismus. Papillae very white. Jan. *11/09*. Intermittent raying.

After each irradiation, large objects became more visible and the nystagmus diminished.

In August, /09, the patient can count fingers with the right eye. Vision in left eye=*0*.

Case *2*. Aged *40*. In a tunnel explosion, Nov. *3/06*, the right cornea was peppered with powder, the lens luxated and vision reduced to counting fingers at five inches. Consecutive cataract.

May *18/08*. Cataract absorbed. Vision = *6/20* with + 10.

Sept. *11/08*. Pupil white; vessels contracted; vision reduced to light perception.

Jan. *4/09*. After seven rayings (intermittent), letters are read at *25* c. m. and the field is enlarged.

Jan. *9*. Has had *21* treatments and vision has doubled since January *4*th.

Case *3*. Aged *21*. December *13/08*. At the age of ten, the patient had an injury of the right eye and could not see clearly after. The vision of the left also diminished progressively.

Vision R. E. = *0*. L. E.=*6/36*.

December *15*. Intermittent raying.

After the twelfth treatment, vision of left eye was *6/12*.

The amelioration continued.

Leprince, of Bruges, reports two cases of optic atrophy treated with the *x*-ray.

Age *28*. Optic atrophy. Madame had diphtheria in August, *1909*, and was treated with serum, since which time, vision has gradually failed. Central corneal leucoma.

Myopia.—*6.00*. Papilla white.

Field. Interior = *30*°. Superior = *20*°. Exterior = *45*°. Inferior = *50*°. Raying with *150* interruptions per minute for five minutes. Ten days later:—Field. Interior, *50*°. Superior, *50*°. Exterior, *80*°. Inferior, *75*°. The last raying. The patient considers herself nearly well.

2. Age *32*. Optic atrophy. The patient had a febrile infection. Vision L. E. = *0.1*. Field.—Interior = *25*°. Superior = *20*°. Exterior = *35*°. Inferior = *25*°.

Treatment with intermittent rays from September *15* to December *1*. *17* seances, when vision L. E. = *0.3*.

Field. Interior, *40*°. Superior *30*°. Exterior, *60*°. Inferior, *40*°.

Leprince says that, in the above two cases of optic atrophy, in which the morbid process was arrested and vision doubled by the use of the *x*-ray, he attained results which he has never accomplished in ten years practice by the use of the continuous current.

Rogers says, "If the *500* c. p. lamp is applied to the body, and locally to the eye for fifteen minutes daily for three or four days, increased arterial circulation will be observed. Gradually the field of vision increases. Nutrition can be partially restored in a large majority of cases, but, if the atrophic process has reached the stage in which there is total blindness, failure will follow. There are grades of impairment, in which treatment will prove beneficial.

Intra-Ocular Optic Neuritis. Choked Disc. — Rogers says: In cases depending upon incurable brain lesion, a cure will be impossible. It may be cured in nearly all cases of syphilitic origin, in many of tubercular origin; and in a portion of those caused by acute fevers and general diseases.

The treatment by a *500* c. p. lamp is both local and general. As the general applications are continued, the systemic infection yields to the repeated oxygenations of the blood; the discs and vision become normal.

CHAPTER IX.

GLAUCOMA.

Dr. S. T .Anderson, of Bloomington, Illinois, advocates the use of the continuous current in glaucoma, and cites a case in illustration of its beneficial effect,—

Mr. D., aged *40*, went to him in January, */87*.

The patient was totally blind in one eye for four years, in the other for four months, and previously, at intervals, for a year or more. A weak galvanic current was applied to the eyes. Two seances daily, of two hours each, were given. The patient reported, "I am able to go where I choose, without help and read medium type under a favorable light."

Leprince states that his observations agree with those of H. Frenkel, who, in fifteen cases found vascular tension increased in fourteen. Leprince advises the use of the high-frequency current to reduce the arterial tension; also advises myotics and purgations; and, often, except in acute cases, he finds it wise to ray the eye.

In using the continuous current, Leprince applies the *negative pole to the eye* and the positive to the nucha, gradually passing a current of thirty to forty m. a. during a quarter of an hour. A notable diminution of tension occurs in the eye treated. The hypertonus gradually diminishes, and, in about twenty-four hours, the tension is equal in the two eyes. By daily treatments, the tension in a normal eye is diminished for several days. If the treatment is suspended, the tension returns to normal.

In my personal experience, I have not found any patient who would willingly tolerate more than ten m. a. of current with an ordinary sized electrode. It is possible that Leprince, with such a current, applied a very large electrode to the eye, but, if so, to avoid misapprehension, the size of the electrode should be mentioned.

Gonzales cites two cases:

1. Serous iritis; pupil rigid, intense pain and great hypertension. He applied atropine and the continuous current. The first treatment diminished the tension and pain. The next day, it reduced the tension lower than in that of the sound eye. He continued atropine and the iritis recovered.

2. Acute Glaucoma. Three days after the onset of glaucoma of the left eye, there was iritis, nebulous cornea, a completely dilated pupil, excessive tension, and vision = *0*.

After one seance of fifteen minutes, with thirty m. a. the mydriasis and tension diminished. The next day the pupil was smaller and vision = counting fingers at *50* c. m.

After four seances, without using eserine, vision was improved and it was possible to perform an iridectomy.

Treatment of Glaucoma by High-frequency.—True, Imbert and Marques, published the first treatments of glaucoma with the high-frequency current. The acuteness of the disease was ameliorated and the arterial tension lowered.

Roure employed the spiral of Guilleminot, which has the same effect as the auto-conduction cage, in the following case.

—, aged *60*, went to him in January, */07*. The left eye has suffered for a long time. The pupil is dilated; tension + *2*; conjunctiva is very vascular; vision quantitative; there is constant pain with exascerbations.

The right eye is slightly hard; pupil normal; arterial tension = twenty-one c. m.

Various collyria had been unsuccessfully employed. Pilocarpin and adrenalin to the eye, and bromine and quinine internally were employed for two to three months, without benefit.

Then, the *high-frequency current* was applied bi-weekly for ten to fifteen minutes. After two treatments, the pain was much diminished. At the ninth and last treatment, the arterial tension was fourteen c. m.; the ocular tension very nearly normal, and there was little pain, while, at the same time, the collyria were about discontinued.

The recovery continued for a year, when a relapse induced the patient to have an enucleation.

M. Vineta treated a patient of *78*, by high-frequency. After seven applications, the pain disappeared and did not return in four years.

In a second case, the pain completely disappeared after the twentieth treatment with auto-condensation for ten minutes and unipolar applications to the eye from an Oudin resonator.

In America, the auto-conduction cage has been completely superseded by the auto-condensation couch or chair.

Chronic Glaucoma. — Allard, in *1899*, reported ten cases relieved by the use of the constant current. He placed the positive electrode along the whole length of the cervical sympathetic, and the negative on the back of the neck, on the opposite side, with fifteen to twenty m. a. of current. In all the cases, the pain rapidly diminished; and, in two, normal vision returned.

Ziegler says, "The positive pole is used in all inflammatory processes of the eye,—*glaucoma excepted.*

A southern oculist, whose name I, unfortunately, have forgotten, reported three cases of acute and subacute glaucoma successfully treated with galvanism. The patients refused operation.

In his first case, he commenced by applying to the eye the positive pole, which produced so much pain that the patient was unwilling to continue treatment; but consented to a trial of the negative pole to the lids. The pain was immediately relieved and recovery followed.

I agree with Ziegler as to the use of the negative electrode to the eye in glaucoma. True, the negative pole is a stimulant and not indicated generally in inflammation, but in glaucoma, even acute, the chief desideratum is to diminish the density of the ocular capsule and the tension; hence, the indication to use the negative rather than the positive pole, which, while it is a sedative, also *hardens tissue* and thus tends to increase intraocular tension by diminishing excretion, which, in turn, promotes inflammation.

Pilgrim cured three cases of glaucoma with galvanism.

1. Aged *50.* Hypertension; anaesthesia of the cornea. Reduced fields; excavations of both discs; vision reduced to *20/200* in right eye and *20/160* in the left. Pilocarpin, without result. After the application of galvanism, the positive electrode to the neck and the negative to the lids, there was immediate improvement.

After twenty-five seances, vision R. E. = *20/40.* L. E. + *20/30.*

2. Acute glaucoma. Vision R. E. = *20/160.* L. E. = *20/30.* After fourteen months of treatment, with the galvanic current, and pilocarpin vision R. E. = *20/40.* L. E. = *20/30.*

3. Aged *29.* Has glaucoma. Pain and tension increased under pilocarpin. The next day, galvanism was begun which diminished the pain and tension.

One year later the field and tension were normal and vision =*20/20.*

Hemorrhagic Glaucoma.—True, Imbert and Marques treated a case of hemorrhagic glaucoma (subacute), which iridectomy had failed to benefit, with the *high-frequency current.* Eleven sittings were given, each lasting from three to fifteen minutes. Coincidently with the improvement of the general arterial pressure, the eyes improved and the patient gained sight enough to count fingers at several meters.

Pensier cites the following case,—

R., aged *53.* The right eye has amblyopia; pronounced opacity of the vitreous with a slight glaucomatous papilla. The globe is hard; pupil inactive. Vision of the left eye is nearly normal. R. E. = *20/200.*

After one seance, in which the direct current was gradually increased for five minutes, the vision equalled *20/75.*

After three sances, vision was *20/50.* The globe softer. There was a recurrence later when neither the current nor iridectomy had any result.

Breuère cites a case. A., aged *57*, came under his care June *14/84.* The left eye had mydriasis. Pain. Vision in left eye = *2/10.* In right eye = *6/10.*

Double glaucoma with opacity of the vitreous.

June *16* the direct current was applied. On June *26* the pain had considerably diminished. Vision of right eye normal. Of left eye *7/10.* June *30.* No pain.

July *5.* This was the sixteenth seance,—Vision L. E. = *8/10.* Later the left eye vision became normal.

CHAPTER X.

OCULAR MANIFESTATIONS OF ARTERIO-SCLEROSIS.

THEIR DIAGNOSTIC AND PROGNOSTIC SIGNIFICANCE.

Veasey, of Spokane, Washington, writes, "I do not wish to convey the impression that all cases of general arterio-sclerosis can be detected by the retinal arteries in the earliest stages. In many cases, the earliest stage of the disease does not manifest itself in the retinal vessels and cannot be detected there until after it has become well advanced in other portions of the body. Probably, among the earliest signs are the corkscrew appearance of some of the smaller arterial twigs, notably those near the macula."

De Schweinitz says, "The pathognomonic signs include changes in the size and breadth of the retinal arteries of such character that a beaded appearance is produced; distinct loss of translucency; decided lesions in the arterial walls, consisting of white stripes in the form of perivasculitis; alternate contractions and dilations of the veins and particularly—and this is the most important of the signs—indentations of the veins by the stiffened arteries in the same manner as a solid rod would indent a rubber tube when lying across it. Finally, hemorrhages manifesting themselves as linear extravasations, etc."

An Index to the General Blood Pressure.—Dr. Melville Black of Denver, considers the venous pulse and blanching of the retinal vessels, induced by pressure on the eyeball, a striking indication of the general blood pressure and advocates it as a valuable test in the diagnosis of arterio-sclrosis. If, he says, while examining the eye-grounds of a patient aged thirty, we apply prssure to the eyeball and find that we cannot cause the venous pulse or blanching of the retinal vessels, we have good reason to suspect increased blood-pressure, and almost invariably the sphygmomanometer will confirm our suspicions. The early recognition of high blood-pressure may mean much to this individual.

A very striking picture is presented in people who have dilated hearts with very low blood-pressure. Here pressure on the globe causes a decided emptying of the arteries, with but little effect on the veins. When arterio-sclerosis is well advanced, no matter what the age of the subject, or whether the general blood-pressure be high or low, little or no blanching of the retinal vessels will take place from making pressure on the globe, and it is equally difficult to produce the venous pulse. I have now given the matter close attention for four years, and I find when referring a patient to an internist for examination that I can almost invariably foretell what the blood-pressure findings will be. This does not mean that this pressure test renders the use of the sphygmomanometer unnecessary. On the contrary, it means that the ocular findings warrant a careful estimation of the blood-pressure by the use of the sphygmomanometer. I have been unable to find in the literature any reference to this pressure test.

D'ARSONVALIZATION IN THE TREATMENT OF HYPERTENSION AND ARTERIO-SCLEROSIS.

Wm. Benham Snow, of New York, writes:—

There are two methods, known respectively as the Auto-condensation and the Auto-conduction methods. In the former the patient sits on a cushion condenser attached to one pole, while his hands grasp an electrode attached to the other pole.

For the administration of these currents a large Static machine, a Rhumkorff coil, or other potential transformer, constitutes the source of electrical energy, in connection with a resonator, consisting of two Leyden jars, a spark gap and solenoid connected in series.

D'Arsonval in his experiments nearly twenty years ago demonstrated the effect of this current upon the arterial tension, and for a considerable time physicians have employed it for that purpose with varying degrees of success, depending upon their knowledge of the technique. It is not, however, until comparatively recent times that the value and import of d'Arsonvalization in the treatment of hypertension and arteriosclerosis has begun to be recognized as a measure of importance in therapeutics. Current literature and discussion indicate that the profession at large is not as yet cognizant of the great value of the systematic employment of this method in the management of cardiovascular diseases. The writer has employed the method in a large number of cases during recent years; and is impressed with its value and importance. There are certain facts concerning the physiological effects of this current which indicate its employment in various conditions.

1. When administered either by the auto-condensation or auto-conduction method, the blood-pressure promptly falls from *10* to *70* m. m. in all except the most advanced cases of arteriosclerosis.

2. That the action of this current is upon the musculature of the arteries and not due to depression of the cardia is demonstrated in the daily treatment of persons of advanced age, in whom the sclerosis is so extensive that it is not possible to affect the lumen of the vessels, and still the blood-pressure does not fall, as it certainly would if the heart was depressed.

3. The administration of the current to aged people in whom there is no fall of blood pressure, after daily treatment for periods of months, is followed by an improvement in general health, attributable to its effects upon general metabolism.

4. In cardiovascular conditions, in which the heart is laboring against other impediments, as mitral or aortic insufficiency or both, associated with hypertension, the lowering of blood-pressure gives indicated relief to the overtaxed cardia. It is for these reasons that d'Arsonvalization fills a most valuable role in the therapeutics of hypertension and arteriosclerosis.

5. It has been stated by some recent writers that hypertension is as a rule compensatory. This, experience teaches to be an error, except in the cases of parenchymatous nephritis, cirrhosis of the liver,, or whenever incidental resistance other than hypertension is present in the path of the circulation. It is a serious error to assume that hypertension is, as a rule, compensatory; because when it is possible to release the heart from the extra labor of a contracted arterial hypertension the arteries are at the same time released from a condition which otherwise seriously interferes with their metabolism and nutrition.

Conclusions. *1.* D'Arsonvalization is undoubtedly the most practical and efficient means of relieving arterial hypertension.

2. D'Arsonvalization produces no depression upon the heart and is consequently contraindicated in no cases of cardiovascular disease, except in those cases in which the hypertension is compensatory.

3. Except in cases of high blood-pressure arising from other obstructing conditions, the tension should be lowered in all cases within a limit of safety, and maintained there by the conjoint employment of d'Arsonvalization and a diet limited in quantity and relatively free from purin bodies.

4. Under systematic routine management hypertension is thus usually controlled, the advance in most cases of arteriosclerosis delayed, and the dangers arising from complicating conditions deferred.

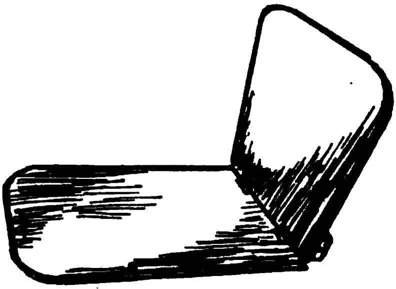


Fig. 105.—Auto-Condensation Chair Pad.

CHAPTER XI.

THE OCULAR MUSCLES.

ACCOMMODATIVE ASTHENOPIA.

While eighty to ninety per cent. of cases of asthenopia, accompanied by refractive errors and muscular inbalance, make satisfactory recovery by correcting the refraction and exercising the muscles with prisms, a small percentage of cases remains which is not thus relieved, and, to which, the application of some form of electricity gives very decided relief. I am in the habit of applying the direct current or the alternating, or the high-frequency vacuum electrode to the lids; and treating the general condition with the high-frequency condensation couch. I am unable to say which modality gives the most relief in the greatest number of cases.

In using the direct current, I usually apply the positive or sedative electrode to the lids, with a current of two or three m. a., for five minutes daily; and, with the alternating current, a mild application for five or ten minutes. With the high-frequency current, I apply the vacuum electrode, which is connected with the top of the resonator, directly to the lids, using a current which is not unpleasantly felt.

The following cases are illustrative of treatment and results,—

Miss G., aged *15*. Reading an hour in the day or a few minutes in the evening causes pain in the eyes and head. Moderate compound hyperopic astigmatism. Exophoria 2° at 20 feet; 8 degrees in accommodation; adduction 9°; abduction 4° at twenty feet; convergence 10 meter angles; stimulation adduction 30° at twenty feet; no insufficiency of obliques; bilateral contraction of fields. Neurotic. Glasses, months of prism adduction exercise, (Gould) prisms of rest, tonics, travel and long vacations afforded no relief to the head or eyes, although her health improved. Positive galvanism was applied to the eyes for fifteen months. She rarely had a headache while under treatment and could read any length of time with comfort during the last month; and, up to her present age,—twenty-five—she has had, at times only, moderate discomfort.

Case 2. Miss —, aged 21. Eyes weak and painful since childhood. Photopsies, insomnia and dyspepsia. Unable to read with glasses prescribed by an oculist, who referred her to me for treatment. After three weeks of galvanism, daily, to the eyes, she could read comfortably any length of time, had no photopsies, and ate and slept well.

Case 3. Miss B., aged 24. Student. Had been previously treated for long periods, by various physicians, without benefit. Has had headache since a child; worse for two months past; has worn glasses since ten years of age. Health,—nervous.

℞. Auto condensation couch for ten minutes daily—and vacuum glass electrodes, with rheostat low on the solenoid, to the eyes, ten minutes daily.

Oct. 26th, a week later. Head breeze daily.

Dec. 1st. Discharged. No headache for a week.

April 24th, /07, writes, "Scarcely a headache since treatment. I have gained in weight and my color is much better.

Case 4. Miss —. Unable to read ten minutes with her glasses; neuresthenic. General electrization only, with high-frequency auto-condensation couch, fifteen minutes daily for a month; after which she was free from headache and could read comfortably for two hours.

Case 5. June 6, /04. Miss D., aged 26. Asthenopia, etc. Eyes ache in the morning after reading in the evening. Light hurts her eyes. Had herpes of right brow and face, accompanied by severe pain, last November. Since then, has had severe pain daily, and worse at night, in the right temple. Had nervous prostration last Christmas and has been very neurasthenic since. Sciatica and pain in various regions, due to multiple neuritis, began last February and has continued since on damp days. Is so exhausted by car ride of ten miles that she can come into the city only once a week. Has been treated by several physicians without relief.

R. E. + .37 cyl. 90° = 20/20. Exophoria 8° at 13 inches. L. E. + .50 cyl. 90° = 20/20. Convergence = 1 m. a.

℞. Convergence exercise with prisms. (Gould's) method.

℞. Auto-condensation couch, daily, twenty minutes; vacuum electrode of high-frequency, with the rheostat placed low on the solenoid and sparking of spine, hip, and other sensitive points and the abdomen for five minutes.

June 30th. Convergence = 7 m. a.

July 31st. Exophoria = 4° at 13 inches. Convergence = 9 m. a. Patient is in fine health. All symptoms of multiple neuritis and neurasthenia and asthenopia have disappeared, and she plays golf all day without undue fatigue. A year later, there is no return of the symptoms.

PARALYSIS OF ACCOMMODATION.

E. F. C., aged *28*, consulted me October *5/04*.

The patient has post-dyphtheritic paresis of accommodation and throat muscles. Had diphtheria six weeks ago.

R. E. + *3.00* = *0.8* Snellen, at *15* inches.

L. E. + *4.00* = *0.8* Snellen, at *13* inches.

Throat,—In swallowing, the fluid goes through the nose.

℞. Interrupted galvanism to eyes and throat for ten minutes daily.

October *20*. "The eyes and throat have recovered perfectly. Can use my eyes with much more comfort than previously."

Pensier cites the following case, —

M. Has complete paralysis of accommodation. Reads at the near point only with + *4.00* D.

June 11, commenced electrical treatment with ten Remak elements; the negative electrode being applied to the nucha, the positive on the orbit then on the superior cervical ganglion. After four seances, complete accommodation was restored.

Arcolio reports two cases of diphtheretic paralysis of the ciliary muscle in which faradism was successful. He also reports that faradism was successful in five cases of accommodative asthenopia.

Giraud-Teulon advises the application of the direct current with the positive pole behind the ear, the negative on the eye. He has seen a sudden return of accommodation in two or three treatments.

MUSCULAR ASTHENOPIA.

Pensier reports the following cases,—

J., aged *11*, came under his care July *18*. Had crossed diplopia; divergence at seven inches = *11*°, vision R. E. = *1/4*.

℞. Separate exercises with right eye and galvanism.

July *30*,—Vision R. E. = *13/20*.

At four inches, divergence = *3*°. Beyond four inches,— = *8*°.

Case *2*. —, aged *32*, has severe neuralgic pain after fifteen minutes work.

July *17*, images crossed with fixation at six inches; at eight inches divergence = *21*°. Right and left eyes are slightly myopic; vision normal. Galvanic treatment.

September *7*,—Prism adduction = *31*°; abduction = *8*°.

Normal condition is restored.

Leprince has found that static and galvanic currents have given him good results in muscular asthenopia.

In one case, of a neurasthenic, who was not relieved in spite of prisms and refractive correction, Leprince employed with success high-frequency with sparking by means of a glass electrode to the eyes.

PARALYSIS OF THE MUSCLES.

1. Mrs. W., aged *23*, consulted me April *9/10*.

She has had vertex headache since last November constantly. Has seen double for the past two weeks.

Esotropia *29*° in left eye from paralysis of the left external rectus. The motion of the left eye is only to the median line outward.

I referred the case to Dr. Grinker for examination of central nervous system. He diagnosed syphilitic meningitis and prescribed potassium iodide and inunctions of mercury. I applied the alternating current to her eyes for twenty minutes daily, and had her continue the medicine.

July *7/10*,—The eye has improved greatly, especially in the last month and is now well. There is no headache.

Orthophoria at thirteen inches and twenty feet; convergence twelve meter angles Motion good.

2. Chas. M., aged *81*, came to me May *3/10*.

He has had diplopia since Friday on looking down to the left. The arteries feel shotty. Hyperphoria. Paralysis of the left external and inferior recti. Vision R. E. = half the length of fingers at two feet.

Vision L. E. = *20/40* with + *1.00*.

There are floating opacities in the vitreous.

℞. *500* c. p. lamp for twenty minutes every second day, at one foot, and Proto-iodide of mercury, grs. *1/4* t. i. d..

May *13*. Vision L. E. = *20/33*. ℞. Alternating current to eyes for fifteen minutes tri-weekly.

July *1*. No diplopia; no hyperphoria; eye motions good; convergence = *6* meter angles.

Vision R. E. = fingers at three feet. L. E. = *20/20*.

While there was mixed treatment in these cases, I can only state it as an impression that the electricity hastened the recovery.

Beard and Rockwell consider that cases of paralysis and paresis of the external ocular muscles, due to cerebral lesions are unfavorable, while early peripheral cases they find favorable.

Benedict says that in seven out of eight cases, referred to him, there was immediate improvement. Paralysis of abducens of three weeks standing, was cured in three weeks by galvanism.

Ball, in paralytic strabismus, applies three m. a. of negative galvanism to the lids, while others use faradism.

Erb cites the following case of paralysis of the right oculomotor. —, aged *70*. Occasional diplopia. Complete ptosis for two months. Recovery after twenty-eight applications of galvanism.

My personal opinion regarding the relative merits of the various electrical modalities in muscular paralysis is,—that, since a paralyzed muscle may respond to an interrupted galvanic current, after it has ceased to react from faradism; and, since the latter has no effect on the nerve centre, I prefer the former current; but a slow sinusoidal current is still much more effective. Electricity is probably most frequently used and less required in this disease than in almost any other eye condition, since there is a great tendency in peripheral cases to disappear spontaneously or by *hot applications;* and tabetic cases disappear and relapse uninfluenced by treatment.

I cite another case which completely recovered with the *500* c. p. lamp,—

H. R., aged *30*, consulted me November *11/11*.

The patient had paralysis of the right external rectus, which had come on suddenly two weeks previously.

Esotropia thirty prism degrees; no ear or nasal disease; no history of syphilis. He came on account of double vision. He had been under strychnia, aspirin and potassium iodide for two weeks without improvement.

℞. *500* c. p. lamp for twenty minutes triweekly.

After the fourth treatment, there was no diplopia or paralysis even in motion to extreme right.

Orthophoria at fourteen feet and at twenty inches.

Recovery complete.

Leprince considers that in cases of muscular paralysis it is wise to apply the galvanic current directly to the muscle, after cocainization.

In paralysis of the third nerve, Leprince employs the static current combined with the galvanic, using three to ten m. a. The static souffle is applied to the lid in ptosis. In seven cases of paralysis of the third nerve, he has seen very rapid improvement under the combined current,—the ptosis has disappeared and paralysis ceased much more quickly than by the application of either current alone.

CHAPTER XII.

OCULAR HEADACHE.

Of the total number of headaches which occur, fifty per cent. or more are caused by eye strain due to refractive errors and, chiefly, compound hyperopic astigmatism.

In my personal experience, eighty per cent. of these ocular headaches have been completely relieved by refractive correction; ten per cent. have been partially relieved; and the remaining ten were not relieved. Of these latter twenty per cent., a considerable number may be relieved by the application of different electrical modalities: the direct, the alternating or the high-frequency current applied to the eyes,—and often by the *x*-ray or phototherapy.

1. Miss C. B., aged *24*, consulted me October *19/06*.

She is a college student. Has had a general headache but more especially frontal, more or less since childhood, and for months past daily.

Glasses.—Has worn them since the age of ten. The glasses relieved her for a time, but all summer an hour's reading would cause headache.

R. Eye,—lost from injury at age of three; L. Eye, with glass, *20/20*. She is nervous of late from hard study. The glasses are correct.

℞. High-frequency couch for ten minutes and vacuum electrodes to the eyes for ten minutes, daily, with the rheostat low on the solenoid.

October *26*. Add head breeze daily to above treatment.

December *1*. Discontinued treatment.

December *6*. Miss B. writes,—"You have helped me greatly. I have had only one mild headache in a week."

April *24/07*. "I have scarcely had a headache since leaving off treatment; my color is much better and I have gained in flesh."

SUPRAORBITAL NEURALGIA.

2. A boy who had suffered daily for four months, had been treated daily for a month with galvanism with little relief and was referred to me for treatment. A high-frequency vacuum electrode, the rheostat being low on the solenoid, applied twice daily to the supraorbit for five minutes relieved the pain completely in five days. No relapse in one month.

FACIAL NEURALGIA.

3. Miss F., aged *16*, consulted me December *28/07*. She had had neuralgia of the right face for two days.

The eyes and teeth were normal; the pain came on every evening during September, when she was out of doors.

℞. *500* c. p. lamp for ten minutes, at one foot; the light intermitted by patient with a fan.

The pain disappeared under the light and had not returned two days later.

Static electricity has been found useful in the treatment of facial neuralgia and has many advocates.

Bergonié recommends the continuous current and offers the following technic,—The intensity of the current should be *50* m. a. or more; the indifferent electrode of *250* to *300* c. m. square should be applied to the back, while the positive pole is placed upon the painful part. In grave cases the current may be used for one hour.

Burch, of Syracuse, N. Y., reports the following case,—

Mrs. W., aged 38, has suffered from tic douloureux, mostly of the infraorbital branch of the fifth nerve, for three winters. Various forms of treatment have afforded her no relief.

Treatment,—Layers of absorbent cotton were applied to the side of the face and temple, with a hole cut in them over the eye. The cotton was saturated with a two per cent. solution of sodium salicylate. A metal plate was placed over the pad and attached to the negative cord.

A similar pad, saturated with a saline solution, was applied over the upper dorsal and lower cervical region and connected with the positive electrode, with a current of twenty m. a. for twenty minutes. The first treatment relieved the pain for twenty-four hours, allowing the patient a good night's rest, such as she had not had for a month.

The patient was treated thus three times weekly for three weeks, when she was entirely free from pain.

Leduc advocates the treatment of neuralgia—rheumatic or malarial—with salicylate and quinine ionization, in solutions of two to three per cent.; with quinine on the positive electrode and salicylate on the negative.

Vitek, of Prague, applies the galvanic current by a new method. In one case, aged 65, galvanism had been used to the external surface twice daily without benefit. He applied a special electrode to the second and third trigeminal branches in the mouth, in the infraorbital region and at the tempero-maxillary articulation; the positive pole being used for five minutes with one to one and one-half milliamperes. He then applied the current to all the mucous surfaces of the jaw, without interrupting the current.

At the end of a week, the patient was completely relieved.

Treatment of Facial Neuralgia With the X-ray.—Leprince reports several cases relieved by the *x*-ray.

1. —, aged *33.* Had had neuralgia of the first, second and third branches for three months. Medication had failed to afford any relief. The attacks occurred ten to twelve times a day.

℞. Radiotherapy, with daily seances for eight days; cessation for four days; treatments lasting one half-hour. There was a notable improvement in fifteen days and complete recovery in two months. No relapse in three months.

2. —, aged *36*, has had neuralgia of the first branch, two or three times a year, for eight to ten days at a time. Rayed three times: Recovery. Relapse seven months later. One treatment, recovery. No relapse in four years.

3. —, aged *32.* Has neuralgia of the second branch. Four months duration. Two treatments secured complete recovery.

4. —, aged *45.* Has had neuralgia of the second and third branches, monthly, for three years.

The patient was given ten treatments during two months. Recovery followed.

5. Has trigeminal neuralgia of six months duration. All medication has proved unavailing. Ten daily treatments with Bergonié's method had not given any relief. Radiotherapy was then prescribed. After eight treatments, the patient resumed his work and sleep and appetite returned. Three weeks interval followed, then one more seance and recovery was complete.

6. —, aged *54.* Has had neuralgia of the third branch for six months. Three weeks of continuous x-ray treatment effected a complete cure.

CONVULSIVE FACIAL NEURALGIA.

Baclère and Haret have found the x-ray effective in cases of convulsive facial neuralgia after surgical methods had failed. They quote an illustrative case,—

—, aged *33*. Has had epileptiform facial neuralgia; has suffered intensely for seven years. Had had all the upper teeth of the left side extracted, and, later, the inferior orbital nerve divided without benefit. The Gasserian ganglion was removed, resulting in some amelioration of the pain, and the cervical ganglion was excised, giving some relief. The pains recurred ten to twelve times daily.

The rays were directed to the alveolar border of the right superior maxilla; four seances were given at one week's interval with the rays directed into the interior of the mouth by means of a glass speculum.

The pain completely disappeared, and there was no return in one year.

Quadei reports a case of one year's duration which resisted all other remedies and yielded to electrical treatment. He applied the carbon pole of a Bunsen battery to the mouth, placing the zinc pole on the fifth pair of nerves.

The patient was relieved immediately after the first treatment. The current was administered daily for one month, leaving the patient entirely cured.

Copiopia.—Eulenberg employed with success, faradism, to the episclera over the ciliary muscle.

Laffe, in a case of chronic periorbital migraine, which had resisted all other treatment, obtained excellent results with static electricity. I cite the case,—

Mdme. A., aged 57. Had suffered day and night for two months with vomiting and dizziness; violent migraine. Laffe treated her with static electricity, with souffle moved over the painful parts. Spark with electric friction. She had thirty-four seances, ten minutes each. Recovered.

Rogers offers the following technic for the treatment of supra—and infra-orbital and ocular neuralgia,—

The *500* c. p. lamp should be applied locally for the relief of pain and generally as well. Applications may be indefinitely continued according to the severity of the disease. The pain is usually relieved in a few minutes.

He adds, "I have seen cases which had been only temporarily relieved by morphia, etc., cured by three to four treatments with the *500* c. p. lamp."

I agree with Rogers in this; I know no agent which so generally, rapidly, and permanently relieves pain as does a high candle power lamp.

CHAPTER XIII.

CONGENITAL AND STRASBISMIC AMBLYOPIA.

Martin considers congenital amblyopia is due to ametropia. The correction of the ametropia, tenotomy, and exercise of vision increase the acuity of vision.

Case *1*. R. Has *2/3* of vision with convergent strabismus.

Vision L. E. = *20/200*, and sees at the near point Snellen No. *20*. No improvement in four months with visual exercises, nor after strychnia injections. ℞. Positive electricity to the lids. Six months later numbers *7* and *8* Snellen were easily read, near and far distant vision had increased to *20/70*.

HEMERALOPIA.

Arcolio used static electricity in seventeen cases of hemeralopia without appreciable lesions. The curative effect was always rapid. The patient was cured after three or four seances.

In a second series of ten cases, in which three were complicated with retinal infiltration, faradism was used with equal success.

AMBLYOPIA OF HIGH REFRACTIVE ERROR.

Cases of high refractive error, which are often accompanied by considerable amblyopia, often do not improve even with the wearing of glasses for considerable periods.

I have benefited such patients so uniformly by treatment with the sinusoidal current that I strongly advise its use in all cases.

1. P. A., aged 5. R. E. + 3.00 + 2.75c at 90° = 20/80. L. E. + 3.00 + 1.75c at 90° = 20/80. Sept. 5/05.

These glasses were worn till May 2/06, when vision in right eye was = 20/100. In left eye = 20/50.

After the application of the alternating current to the eyes for fifteen minutes, tri-weekly for two and one-half months, the vision in each eye had improved to 20/25, amply illustrating the possible benefit of electrical treatment.

2. September 23/11. M., aged 7, schoolboy. Referred to me by the school examiner, on account of low vision, which with either eye is 20/50 with correction.

The sinusoidal current was applied to his eyes tri-weekly for four weeks, after which he read with each eye 20/30.

3. August 21/11. Dora, aged 7. Is wearing + 6.50 cyl. at 90° and is unable to read with these 20/100.

With correction, vision of either eye = 6/15.

℞. Sinusoidal current to be applied to eyes.

December 5/11. The child has had fifteen applications and reads with either eye 6/7.

4. August 22/11. Child aged 10. Has high refractive error. Vision in either eye = 20/50. Under the application of the sinusoidal current to the eyes until Nov. 18, the vision of the right eye improved to 20/30 and the left eye to 20/40.

MYOPIA.

Dr. Burdick reports that a Dr. Marsh after experimenting with the *x*-ray, observed that his eyesight improved so much that glasses, previously worn, were dispensed with.

HIGH MYOPIA.

March, *1911*. Mrs. M., aged *48*. High myopia, floating bodies in the vitreous, disseminated atrophic choroiditis. Complains of considerable pain in her eyes.

After four weeks of galvanism to the eyes daily, she says the pain has been very much relieved and her sight improved, but testing shows the same vision = *20/100*.

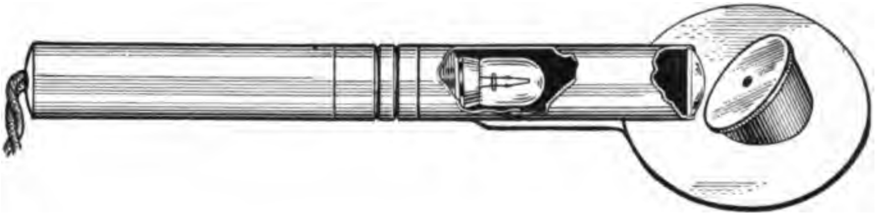


Fig. 106.—De Zeng Electric Retinoscope.

AMBLYOPIA EXANOPSIA AND STRABISMUS.

Notwithstanding the contention of Schweigger, in *1883*, and his followers, that the amblyopia of strabismus is congenital, I believe that it is due to the non-fixation of the eye, or the so called amblyopia exanopsia. For, in patients under twenty-one years of age, vision is improved by operation in ninety per cent. of the cases.

1. January *12/10*. Mrs. H. J. R., aged *30*. Has amblyopia exanopsia, or, congenital amblyopia.

The right eye has been operated on for convergent strabismus.

Vision R. E. = *20/50*, with + *5.00*. L. E. = *20/50* with + *3.50* + *1.50* at *105*°.

℞. The sinusoidal current every second day for ten minutes to the eyes.

Feb. *12*. Has had seven treatments.

Vision R. E. = *20/33*. L. E. = *20/40*.

In the above case, I am not aware what the vision of the patient was before the operation, so cannot say whether the amblyopia was congenital or due to the strabismus.

2. —, aged *37*. Right eye has diverged since childhood and can see only the tips of the fingers at six inches.

Has felt in danger from moving objects in the street, approaching on his right side.

℞. Sinusoidal current for three months. At the expiration of that time, the patient can count fingers at two feet and he is much pleased at being able to see objects approach from the right.

ALCOHOL AND TOBACCO AMBLYOPIA.

In cases of tobacco and alcohol amblyopia, the withdrawal of the toxics is naturally followed by improvement in vision and is often sufficient to insure recovery. Hence I make no claim that it is certain that the use of electricity hastens the favorable result.

1. April *18/05*. T. F., aged *44*. Patient has tobacco and alcohol amblyopia. Vision, right or left eye = *20/200*. His sight has been failing for two months. Fundi; discs are cloudy. He has smoked four to five cigars daily and taken fifteen to twenty glasses of whiskey up to six weeks ago. No sugar or albumen in the urine.

℞. Discontinue the toxics. Sinusoidal current for ten minutes daily to the eyes.

May *1*. Vision R. E. = *20/33*. L. E. = *20/50*.

May *8*. Vision R. E. = *20/33*. L. E. *20/40*.

May *30*. Vision R. E. = *20/20*. L. E. = *20/25*.

2. March *11/10*. J. J. B., aged *52*, accountant. Has tobacco and alcohol amblyopia. His sight began to fail three months ago and grew worse for one month. He has smoked twenty pipes a day since a boy of eighteen, and during the past four years has smoked all day. He usually takes two whiskies each day. General health is good.

Vision R. E. = *20/200.* L. E. = *20/100.*

Previous Treatment.—Since Feb. *1/10,*—Iodide of potassium, quinine and iron; with hypodermic strychnia daily.

℞. The sinusoidal current for fifteen minutes daily.

March *17/10.* Vision R. E. = *20/200.* L. E. = *20/66.*

Patient discontinued treatment.

3. In this case of tobacco and alcohol amblyopia, vision rose, in nine days, from *20/200* to *20/60* in right eye, and from *15/200* to *15/18* in left eye, with the sinusoidal current.

December *23/08.* D. S., aged *34.* Sight had been failing for ten days. Vision R. E. = *20/200.* L. E. = *15/200.* Fundi and fields are normal. Has smoked fifteen cigars daily for fifteen years, and taken a gallon of native wine on Sundays and holidays.

℞. Stop alcohol and tobacco. Apply the sinusoidal current to the eyes daily, ten volts for fifteen minutes.

January *2/09.* Vision R. E. = *20/60.* L. E. = *15/18.*

Leprince treated the following case of tobacco and alcohol amblyopia with the constant current, five m. a. daily for twenty minutes with recovery.

A. B. has had tobacco amblyopia for six months; there is central scotoma and the lens *14.00* has to be used to decipher letters, the papillae are decolored and he has intense photophobia.

Ten treatments with the constant current as described above were followed by complete recovery.

Parasotti favored the use of galvanism in tobacco amblyopia.

Romiée observes that galvanism always produces an amelioration.

Pensier says that the patient must, of course, renounce his habits. He cites the following case.

C. L., aged *52*. Had a habit of drinking a little. For eight months he had observed failing vision, especially of the right eye. November *25*, with quantitative vision, strychnia was given. One month later, there was no improvement. Exudation along the vessels and the papillae are gray. The constant current was applied daily and after the eleventh seance the patient read easily slightly enlarged letters.

HYSTERICAL AMBLYOPIA.

Hysterical amblyopia admits of so uncertain a prognosis—a case sometimes recovering in a very brief time, and again, at the termination of many months without any treatment—that we cannot be certain that the case has been benefited with treatment, electrical or otherwise. Although it is characteristic of the disease to recover suddenly without treatment, we may fairly infer, when a case has improved gradually after the use of electricity or medication that the favorable condition is due to the treatment.

1. —, aged *10*. Was referred to me by an oculist who had treated him for a year without improvement.

Vision, right or left eye = *20/80*. Vision has been failing for two years. A diagnosis of retinitis without pigment had been made. Extreme nervousness; no night blindness; retinal vessels and discs normal; field *20*° and a frequent diplopia suggest hysterical amblyopia.

After eleven months of the alternating current without improvement, I thought of discontinuing treatment, but gave him four months more, when vision in each eye rose to *20/25*.

2. Mrs. —, aged *44*. Never had good eyes, vision failing for nine years. Has had a dozen voluntary abortions. Fundi normal. Reversal of the blue and red fields. Subject to temporary hemianopsias. Vision R. E. = *20/200*. L. E. = *20/100*. The alternating current was applied to the eyes and the patient was on the high-frequency auto-condensation couch daily for ten minutes. Vision rose in R. E. to *20/25*. L. E. */20-25*.

In neurasthenia and defective metabolism the auto-condensation couch has uniformly improved the patient and given me more satisfactory results than any other course of treatment.

Leprince treated successfully five cases of hysterical amblyopia with static souffle to the closed lids for five to ten minutes; and, in hysterical blepharospasm, he found one seance sufficient for recovery.

Pensier reports a case of hysterical amblyopia,—

—, aged 16 years. Rapidly acquired amblyopia. Vision R. E. = nil. L. E. = light perception. General anaesthesia. Half an hour after the application of three twenty-franc pieces to the temple, the vision of the left eye increased to *1/10*. R. E. = *0*.

March *4*. The vision remained stationary at *2/5*. Static sparks around the orbit. After a few seances, the visual acuity became normal.

2. F., aged *28*. Noticed upon waking that the vision of the right eye had disappeared. The left pupil is dilated. Right eye has not even light perception. No lesion of fundus. The left eye has the same appearance but with normal vision.

Treatment,—Heurteloup leech to the temple; hypodermic strychnia; and direct current daily for five minutes. In six weeks, vision was restored.

CHAPTER XIV.

ERRORS OF REFRACTION.

In an article on Electrical Massage in Errors of Refraction Samuel J. Harris, of Boston, writes:

It was my success in the treatment of atrophy of the optic nerve, in glaucoma, and in embolism of the central artery, and the amelioration of sight in these cases by means of electricity, that first led me to turn my attention to its use in errors of refraction. I now use galvanism, faradism and the high frequency current, as may be indicated, in refractive cases, but in this paper I shall limit myself to the uses of electrical massage. Massage has been used in affections of the eye since the time of Hyppocrates but it was left to Donders to formally introduce eye massage to the ophthalmologists at the London Congress in *1872*. Pagenstecher has done more than anyone else to spread the knowledge of this therapeutic agent. His method consists of "moving the lid as quickly as possible under light pressure in a radial direction; starting from the center of the cornea, and after this, by making circular friction by means of pressure upon the upper lid around and upon the sclero corneal margin." Maklakow (*1893*) employed Edison's pen, taking his power from an electric vibrator which is capable of giving *9,000* vibrations per minute. The vibrations provoke a contraction of the pupil, set the aqueous humor in motion, are transmitted into the depths of the eyeball, reduce intra-ocular tension, hasten the lymphatic circulation and facilate intra-ocular exchanges. Dr. Dormec describes his method of massage in errors of refraction as follows: "the end of each thumb is applied to the center of the cornea through the upper eyelid, the fingers being extended flatwise upon each temple. One soon acquires the delicacy of touch sufficient to feel if the cornea shifts about under the thumb and to make the pressure successive and not continuous. The duration of each massage is about five minutes, with one or two intervals of rest according to the individual sensibility. The pressure may be applied quickly or slowly; eventually, *500* pressures are made in the sitting. It is necessary in asthenopia scarcely to touch the eye at first, or the patient may give up the treatment after the third or fourth day."

In September, *1906*, I began by using Maklakow's electric vibratory massage, then Domac's pressure massage, finally using pneumo massage, taking my power from an electric motor with pump attachment and later using vibratory massage taken from the handle of one of our new electric vibrators. I have found pneumo and vibratory massage almost of equal benefit and both superior to the ordinary pressure massage. The vibrations taken from the transformer and the vibrator are more accurate and can be better regulated than those of the ordinary digital pressure massage, as well as being much more agreeable to the patient; and, I think, are both superior to digital pressure massage. I often use pneumo and vibratory massage on the same patient, usually starting with the pneumo and ending with the vibratory, excepting in cases where I wish to get very deep pressure, then I employ vibratory massage and use the vibrator placed in the palm of my hand, giving the vibrations with the forefinger on the eyeball, just over the cornea. In using pneumo massage, we may use a rubber capped massage handle or may use glass eye-cups connected with the machine by a rubber tube. The force is taken from a transformer and a pump attachment. The nipple of the pump is placed at a point two-thirds distance to the right when we obtain alternate compression and suction.

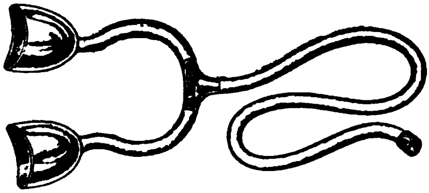


Fig. 107.—Pneumo-Massage Glass Cup.

Great care should be exerted that the stroke does not cause any discomfort—the slower the stroke, the better it is. The best results are obtained with *50* to *250* vibrations per minute. In using the vibrator, one may use a shallow cup vibratode placed on the eyeball, or may place the vibrator handle in the palm of the hand, where we obtain about four hundred vibrations per minute, the forefinger being placed upon the centre of the cornea through the upper lid. Irreparable injury may be done, such as retinal detachment, unless one is extremely careful, and I believe this method should be practiced only by an expert. I prefer my finger to the cup-vibratode. If a sitting is given with both pneumo and vibratory massage, about two to two and one-half minutes should be given to each. The fibres of the zonule of zinn are stretched by each pressure upon the cornea and finally, the zonule is lengthened. The action of the ciliary muscle being increased, the power of accommodation is rapidly augmented. The fibres of the zonule permanently remain more or less distended, which accounts for the diminution of the hypermetropia.

Method of Procedure.—Visual acuity is noted with and without refractive correction. The eyes are massaged for two to five minutes for ten consecutive days, the refraction noted at each sitting; and at the end of ten massages, the refraction is again carefully noted. I find, in many cases, the effect of the massage has been so beneficial that no glasses are needed and, in others, a weaker glass than would have been needed before the massage treatment.

Hypermetropia.—Out of two hundred children, ranging from ten to fifteen years, having a hypermetropia of *.50* to *3.00*, D, one hundred of them have been able to go without glasses, fifty of them needed only very weak glasses, and the other fifty required glasses less than half the strength of those they originally wore. In some cases, the improvement is immediate, and in others, it is not noticed until after the ten sittings. In forty per cent of the cases, ranging from fifteen to twenty years, no glasses were needed; in sixty per cent, ranging in age from twenty to fifty, I was able to reduce the error and prescribe weaker glasses than would have been required before the treatment.

Amblyopia. — Where the eye is blind from disease, I massage the eye for ten consecutive days: if vision improves after the first day, it is a good augury; as soon as sight is a little improved, I prescribe glasses which correct the ametropia, so that the eye is capable of seeing without the aid of the sound eye, which is then atropinized for some ten days, when glasses are prescribed, correcting the hypertropia remaining. I have used this treatment in about twenty-one amblyopic eyes with great success. In case there is squint, hyperphoria, exophoria or esophoria (and *20* to *70* per cent of all squinting eyes are amblyopic), I combine the above treatment with moderate pressure to the spine, with the ball on each side from the occiput to the sixth cervical, because of the effect on the muscles of the eye.

Asthenopia. — There are three varieties,·muscular, retinal and accomodative, the latter by far the most common. I have seen such a large number of these accommodative cases, where all forms of ordinary treatment had failed, that massage seems like a panacea. In massaging such cases, it is necessary at first to scarcely touch the eye. I begin with massage of the eye followed with interrupted vibration to the spine. In one hundred of these cases massage enabled *50* per cent to go without glasses; in *20* per cent the symptoms were relieved by wearing glasses weaker than had been worn before.

Myopia.—I subject these cases to massage. In more than one hundred and fifty of these cases, of young subjects with slight myopia, in *40* per cent glasses became less useful. In *10* per cent sight improved from ½ of vision to 2-3 of normal or to normal with the same glasses. In high myopia, *70 %* of the cases improved. In progressive myopia, the increase was stopped in *60* per cent. In these cases, it is necessary that the seances be numerous and repeated for two to three months in the course of a year. In certain myopes, vision augments as the massage increases.

Astagmatism.—I designed a spherical eye-cup with a partition on each side of the cup to allow the air to massage any meridian desired. So far, my success has been all I expected, but it has not been in use long enough to state what the results of its use will be.

Presbyopia.—I have found that by massage 20 per cent of these cases may postpone the wearing of glasses. I believe the improvement is due to the mechanical action upon the crystalline lens and the tonic effect upon the ciliary muscle.

Conclusions in Part.—I believe the amelioration of sight may be divided into three groups:

1. Mechanical action, as regards the zonule and the crystalline lens.
2. Tonic action upon the ciliary muscle and the accommodation.
3. Trophic action (circulatory, secretory and excretory), upon all the intraocular tissues and liquids, ciliary glands, chorio-capillaris, retina, etc. I believe electricity in its various forms to be one of the greatest additions to the armamentarium of the ophthalmologist, and, in the future, must become his greatest ally.

THE OPHTHALMO DIAPHANOSCOPE.

Dr. H. Gradle, of Chicago, in a personal communication, says: "By this illuminator, the posterior parts of the eye can be very well explored for tumor, retinal detachment, or vitreous opacities. The instrument is an eighty candlepower Tungsten lamp, enclosed within a water jacket, which is a reflector. It is used by putting it into the mouth of the patient. We get a fair view through the dilated pupil of the posterior orbit. It is also used for transillumination of the accessory sinuses."

AN IMPROVED ELECTRIC OPHTHALMOSCOPE.

Dr. Wilbur B. Marple, of New York, in offering this new instrument, writes: "I want to say that it is Dr. Dennett's ophthalmoscope, with two or three modifications. The lamp is moved up and down by means of a little knob. In the use of the ordinary reflecting ophthalmoscope, the most difficult thing to learn is the management of the illumination. In my electric ophthalmoscope, the illumination takes care of itself, and this renders it especially useful to the medical man—not an ophthalmologist. My electric attachment can be put on any form of ophthalmoscope to which the individual is accustomed."

Dr. G. E. DeSchweinitz, of Philadelphia, said that he has never used an electric ophthalmoscope that is so complete and satisfactory. That, for the study of opacities in the media, it is entirely satisfactory. That, with it, indirect ophthalmoscopy does not seem as readily employed as with the ordinary ophthalmoscope, although when more familiar with the instrument he expects to find it respond to every requirement.

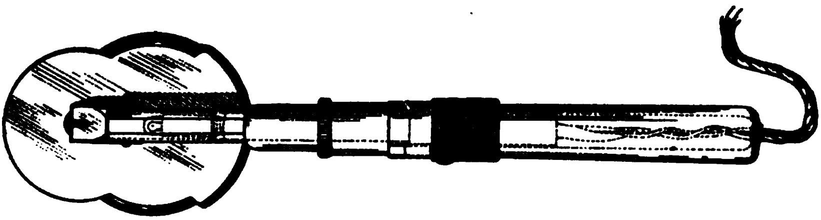


Fig. 108.—Dr. Dennett's Electric Opthalmoscope, Improved by Dr. Marple.

The Dennett electric ophthalmoscope affords a means of examining a patient in any position and of readily directing the light. It also yields a *modified* light for fundus examinations—the advantages of which have been pointed out by Suker.

CHAPTER XV.

MALIGNANT DISEASES OF THE EYE.

EPITHELIOMAS AND SARCOMAS.

Leprince writes: In case extirpation is refused by the patient, or plastic operation produces too much deformity, we have at our disposal x-rays, high-frequency sparks, the fulguration of Keating-Hart, the electro-coagulation of Doyen and the application of radium.

X-rays.—Observations regarding the cure of epithelioma of the lids by x-rays are no longer questionable. Nevertheless, the disease is particularly tenacious and often demands extirpation. Always, after excision we advise the use of x-rays, which prevent recurrence.

Certain granular epitheliomas are very tenacious. In these cases, high-frequency sparking completes the recovery. A treatment daily for eight days usually suffices.

High-Frequency.—Sparks taken from the resonator, have been employed with remarkable results in the treatment of small epitheliomas of the face. Bordier considers the procedure an enormous advance over the former electrolytic methods, not alone on account of its rapidity and convenience of application, but also on account of the superiority of the esthetic results,—the cicatrix being much less visible, than after the use of the electric needle. Besides, the high-frequency would be preferable to photo- and radiotherapy—these two last procedures being, by contrast, indicated in extensive epitheliomas.

Oudin considers this method as the treatment of choice in small epitheliomas of the skin and mucous membrane, not only because one can limit the action of the sparks with greater facility, but also because of the rapidity of the results. The number of treatments never exceeds twenty-three.

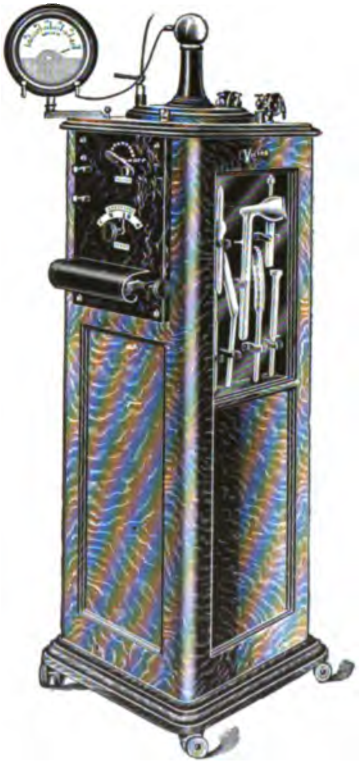


Fig. 109.—High Frequency Machine.

Like Bordier, Oudin prefers high-frequency to the x-ray, which is often difficult to use on account of the location and slight extent of some of these neoplasms; for instance, the ala of the nose or angle of the eye. One can employ a conical metallic electrode. The flowing of the balls of sparks may be regulated so as to have only a spark of two to three m. m. The operator holds the left hand of the patient with his left hand,and, holding a hand electrode in his right hand, applies the point of the cone to the skin.

After continuing the spark for a minute upon the tumor, he gradually releases the hand of the patient. When the surface commences to pale, he separates the cone a little from the tissue and the sparks become longer. The operator has the advantage of producing anesthesia of the skin in proportion to the application.

Leprince's method is, in his own words: "With the electrode connected with the Oudin Resinator, I lightly touch the skin and make a fresh series of sparks. Following this, I make with a conical electrode, a light fulguration at the point of contact, then at a slight distance. So soon as the skin begins to white all around the tumor, I interrupt the treatment to resume it eight days later. The pain is very bearable, the sparks, at first, being very light and progressively increased by the aid of a regulating electrode."

Fulguration.—The results obtained by Dr. Keating-Hart by the employment of fulguration in very painful cancers of the face with the extension to the orbit and eye are very impressive. I cite five of his cases.

1. —, aged *75.* In the St. Louis hospital. There is an exceedingly painful epithelioma of the left eye. Fulguration in April, *1908.* Removal by Prof. Gautier, by curettage. Prudence prevented the cleaning out of the frontal sinus involved. Perfect cicatrization of all the region fulgurated. Disappearance of the intense pain. Radium, previously used, had failed. Partial success.

2. —, M.—a patient of Dr. Villard of Marseilles—has epithelioma of the eye, the maxillary sinus and the ethmoid. Severe pain. Fulguration on September *30*, *1907*. Curettage of the bone and enucleation of the eye. Suppression of pain and cicatrization during one year and a half. Probability of relapse very slight.

3. M. B., aged *55*. Epithelioma relapsed to former painfulness in the region of the oculo-maxillary and subjacent bone. Had several previous successive operations and radiotherapy without success. Severe pain. A fulguration and curettage, and sparking. Cicatrization nearly complete and disappearance of pain. Curetted seven months later. Since then, the vast bony cavity has completely filled up. The patient no longer suffers and presents an appearance of health during the past year and eight months.

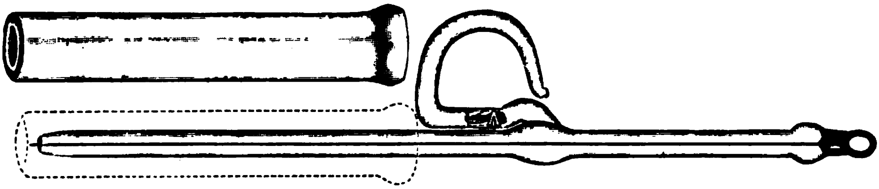


Fig. 110.—High Frequency Fulguration Electrode.

4. M. V., *78* years. Parenchymatous epithelioma of an encephaloid lobular type in the right naso-ocular region involving the osseous surfaces. Fulguration. Amputation and excision of lesions, avoiding the angle of the eye. Recovery in eighteen months.

5. M., aged *50*. Epithelioma at the angle of the eye and of the adjacent bone. Caillaux of Monaco had made a great number of operations and x-rayed without success. The first fulguration was in May, *1907*. Remarkable cicatrization. Slight retouching in May, *1908*, February, *1909*, and July, *1909*. Good condition thereafter.

6. M., aged *61*. Epithelioma of eye and antrum had been treated by radiotherapy with some improvement by Dr. Brock. In February, *1908*, the eye had been enucleated. Cicatrization was not complete. Fulguration February *10*, *1909*, and curettage of the superior maxilla with excision of the soft parts. Cure complete eight months ago.

Tousseau has also employed fulguration without surgical ablation. If fulguration has not been effectual, there will not be any modification of the appearance of the doubtful parts. Nevertheless, it is not a method that we can neglect in case of involvement of the sinuses and cavities of the face when they have been previously curetted.

Mary Cushman Rice, of Chicago, advocates the high-frequency current with the glass vacuum electrode as an adjunct to the x-ray, in the treatment of epithelioma, rodent ulcer, etc.

1. Epithelioma below the left eye. I gave both the x-ray and high-frequency current at the same sitting, says Dr. Rice. Suspended treatment after reaction following the fifth sitting. A month later, the growth had disappeared.

2. Epithelioma below the eye. Twenty-one treatments by the x-ray. Dermatitis. Then recovery under glass vacuum high-frequency electrode.

It is to be noted that in this case, when the x-ray alone was used, twenty-one treatments were given as compared with five in case 1, in which the x-ray and high-frequency were used at the same sitting.

In a personal communication, Dr. Rice cites three other cases, in which she attributes success largely to the mixed treatment:

1. Mr. P. has a rodent ulcer below the right eye. It failed to heal after three months' treatment with *x*-ray. Three applications of the high-frequency spark vacuum tube resulted in complete cure.

2. Mrs. A. Epithelioma on the nose. Fifteen *x*-ray treatments and two treatments by fulguration cured the case.

3. Mrs. T. Epithelioma on upper lip. Much improvement after four months' treatment by x-ray, but healed after three treatments with fulguration electrode.

Dr. Rice adds: "I have treated many moles, warts and pigmented naevi by fulguration, with excellent success both as to permanency of cure and cosmetic effects."

John McIntyre, of Glasgow, says: "Judging from the workers with whom I have come in personal contact, I should say that the most striking results in lupus, rodent ulcers, and superficial epithelioma have, so far, been obtained by means of the excited *x*-ray tube. Where an operator has asked my opinion as to the most useful of these agents,—Finsen light, high-frequency current and *x*-rays,—in these three affections, and when he has been desirous of selecting one, I have, of late, suggested *x*-rays in preference to the other two."

Newcomer, of Philadelphia, has successfully treated thirty cases of lupus with the *x*-ray, few of which have shown any disposition to recur.

Ring says that in a considerable group of cases of epithelioma, several of which were inoperable, all recovered under the *x*-ray.

Mayou, Pusey, J. Green, Jr., C. L. Leonard and others report cures in all cases treated with the *x*-ray. Pusey says: "No relapse in three years."

Sweet had eighteen successes out of twenty treated with the *x*-ray.

De Schweinitz had, in six cases, four recoveries and two were possibly aggravated.

Neiswanger, of Chicago, in a personal communication, writes thus of small epitheliomas, especially about the eyes: My recent experience more firmly convinces me that zinc cataphoresis is the best method of destroying epithelioma, one application being all that is necessary.

Technic.—I employ a saturated solution of zinc sulphate on the anode with a platinum, aluminum or block tin electrode, around which a pledget of cotton is wound. The cathode pad of a constant current is placed on an indifferent point. The cotton is saturated with a ten per cent solution of cocaine and applied to the lesion, using five to ten m. a. for five minutes. The cotton is then squeezed dry, dipped into the zinc solution and applied to the sore. The current applied varies with the size of the lesion —from three to ten m. a.—and is continued until every portion is turned white.

I cite two cases:

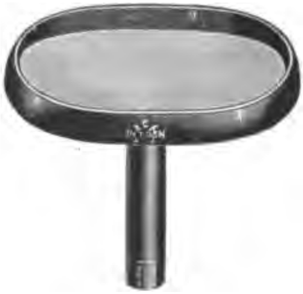


Fig. 111.—Neiswanger's Cataphoric Electrode.

1. Mr. S., aged *65*, has epithelioma on central margin of lower lid; which has eaten out a V-shaped piece one-eighth of an inch deep. One application to the everted lid made a complete cure.

2. K., aged *60*. Referred by Dr. E. J. George. Has an epithelioma involving entire canthus of left eye. One application was sufficient; the Doctor reporting that the "case was entirely well in two weeks."

Concerning the efficiency of the *500* candlepower lamp in the treatment of epithelioma, Rogers writes: If the necrotic process has reached an inaccessible point, or, if it has reached a point so near the eye that cauterization would destroy the eyeball, the case is inoperable unless the globe is first enucleated. All those cases in which the destruction of tissue is not extreme, or in which the effected bony and glandular structure may be surgically removed, may be successfully treated with the *500* candlepower lamp.

Technic.—Apply ten per cent cocaine to the surface for fifteen minutes. Remove all moisture. Dip six to eight pieces of *1/16* inch asbestos paper in water and remove superfluous moisture. Make a hole in the sheets a little smaller than the lesion. Mould the asbestos papers, one at a time, around the lesion including the indurated edge. The thickness of the pad should protect the underlying parts from being blistered. The *500* c. p. lamp should be brought close to the lesion. Cauterize thoroughly and destroy the disease by one application. Apply the lamp daily afterwards to hasten recovery and prevent the formation of a cicatrix.

Chronic Ulcer.—Dr. F. B. Bishop reports a case of chronic ulcer successfully treated by metallic electrolysis, after the *x*-ray and high-frequency currents had failed.

—, aged *60*. A scaly spot had appeared just below the inner canthus fourteen years previously. This broke down and appeared malignant. The ulcer, the size of a twenty-five cent piece, exuded a dirty pus.

The *x*-ray was applied for ten minutes, every other day for ten treatments, but the ulceration spread more rapidly. The high-frequency was then used daily for two weeks; then on alternate days,—the *x*-ray being used every second day, for two weeks more. The ulcer had grown and threatened the destruction of the eye. I decided to stop the *x*-ray and to try a modified method of Dr. Massey.

With a zinc electrode, well amalgamated with mercury, a current of eight m. a. applied; the positive electrode held to the ulcer and moved around. This was kept up till the whole surface was whitened. In all, ten treatments were given with rapid healing of the ulcer, which remained well after three months.

Sarcoma.—Dr. J. E. Harper, of Chicago, reports a case of melano sarcoma, successfully treated by the *x*-ray.

Mr. H., aged *23*. There is a growth on the sclera of one year's duration. It was excised, leaving three small dark spots of cancerous pigmentation. Treatment with the *x*-ray began a week later and continued for three to five minutes daily, with sometimes two or three days discontinuance, for a month, when there was left one speck of pigmentation. Nine and one-half months later, the appearance indicated there was no likelihood of its return.

Rodent Ulcer.—G. H. Stover, of Denver, cites two cases of effective use of the *x*-ray in malignant eye disease:

1. Rodent ulcer at internal canthus. A lump appeared six years previously. It improved under forty-five exposures to the *x*-ray.

2. Carcinoma below the canthus, of four years' duration. Recovery after twenty-two exposures to the *x*-ray.

LUPUS.

Leprince considers that the high-frequency, with effluve and sparking gives the most satisfactory results in lupus erythematosa; but in tuberculous lupus, he prefers the *x*-ray and phototherapy.

Bordier uses Krohmayer's lamp in treating lupus. He gives exposures of fifteen to twenty minutes, with the quartz lens applied to the skin. The therapeutic result is much more satisfactory and beautiful than with radiotherapy.

Radiotherapy is the method of choice in the treatment of large surfaces.

Xanthelasma.—Leplat, of Lieges, considers the treatment of xanthelasma to be essentially electrical. He uses a hypodermic cathode needle for injection, applying two to four m. a. through this needle, which is left till it is encircled with foam. Nine seances are given.

Villard and Bosc employ a bipolar needle with six to eight m. a. The skin becomes greenish and bloated. Recovery occurs in three or four weeks.

Epithelioma of the Orbit.—Dr. A. T. Bristow, of Brooklyn, reports a case of epithelioma of the orbit, successfully treated by the *x*-ray. The case was in the hospital for thirteen months and was unsuited for operation.

X-ray treatments, of fifteen minutes' duration, were given every second day until fifteen had been given; after which, twice weekly. The patient was treated without a shield and only the diseased tissues were acted upon.

Sarcoma of the Orbit.—Morton, of New York, injects the tumor with quinine bichloride, which becomes phosphorescent under the *x*-ray, and is thus influenced by *x*-rays, violet and ultra-violet rays.

Fox reports a case, inoperable, involving the orbit and accessory sinuses, which was apparently cured by fifty exposures, with a high tube at ten inches, for five minutes daily during four weeks, then less frequently.

Beclère had a case of sarcoma of the orbit of four years' duration, which had been twice operated upon, and he succeeded in curing it with *x*-rays.

Kienboch treated a growth of seven years' standing, which, after thirteen exposures to the *x*-ray, entirely disappeared.

Theobold reports an operable case which recovered by raying in seven months.

Pfahler had three cases recover and one fail to improve with *x*-ray treatment.

Westcott, of Chicago, in a case of incompletely exenterated sarcoma, rayed the patient for three months. Recovery and no recurrence in one year.

Bull, in eight cases, has not found *x*-rays of any value either before or after operation, except in relieving the pain.

Vascular Tumors of the Orbit.—Barry treats these by electrolysis, using one needle or a bipolar needle, with a current of ten m. a. for five minutes.

Carcinoma.. Bulson, with four extensive cases, reports two cured; one probably cured by *x*-ray; the fourth discontinued treatment.

Bull cites two extensive cases, involving the orbit; one was cured by twenty-seven exposures and the other by thirty-four.

Wurdemann, of Milwaukee, reports a case, in which the orbit had been exenterated, and parts of the adjacent bones removed. He exposed it several times weekly to the *x*-rays for two years, with complete recovery.

ORBITAL CELLULITIS.

I cite the following interesting case of orbital cellulitis, illustrative of the benefit of phototherapy and *x*-ray treatment.

A boy, fifteen years of age, consulted me about his eyes; the right one had been red for eight days; proptosis one-quarter of an inch directly forward; eye nearly immobile; vision *20/200*; no pain or tension; choked disc; hazy vitreous; retinal veins large and tortuous; the left eye slightly involved. Dr. Brawley, in consultation, concurs in the opinion that the accessory sinuses are normal.

Treatment.—Aspirin, violet light *50* c. p. for half an hour daily, iodonucleoid, exploratory incisions to the apex of the orbit. No pus appears. No improvement.

I seriously considered the advisability of removing the eye, but concluded to first test the effect of *x*-ray treatment, combined with the use of the *500* c. p. lamp. The former was used for eight minutes daily and the latter for a half-hour twice a day.

In five weeks, recovery was complete with vision *20/20*. The *x*-ray seems the more important factor in the recovery, as a *50* c. p. lamp had been previously used, though the *500* c. p. may have been more effective.

CHAPTER XVI.

ELECTRICITY AN AID IN THE DIAGNOSIS OF EYE DISEASES.

Regarding Electro Diagnosis in Eye Disease, Sinclair Tousey, of New York, writes:

It has been known, for a long time, that the passage of electric currents through the eye would occasion luminous sensations, and, that the making and breaking of the current, and changes in its intensity were especially productive of these sensations. The color and shape of the luminous subjective image have varied so greatly under similar conditions that it is probable they are different in different individuals. It is supposed that there is no direct communication between the strength of the current and the color and intensity of this luminous image. The luminosity is certainly not excited by electrification of the brain itself. Currents which pass between the electrodes placed at the two sides of the head do not produce any sensation of light, although it has been proven that such currents, even if as weak as *1* m. a. do actually traverse the brain substance. Currents applied to the temples, however, do sometimes produce luminous sensations, and it seems probable that these currents traverse the eye or the optic nerve in part. A long series of observations, by different men, has shown that the sensation of color and light is due, chiefly to excitement of the retina, but partly also to excitement of the optic nerve. It will take place, for instance, after the eyeball has been removed. In the healthy eye, placing the negative electrode upon the temples and the positive upon the upper eyelid, a current of *3/10* m. a., or sometimes only *1/10* m. a. is sufficient to excite a visual sensation in the eye. After removal of the eyeball, however, a stronger current is required. In one case tested *8* days after enucleation, *1* m. a. was required; in another case, one year after enucleation, *1*, *6/10* m. a. were required; and in one case, five years after, *3* m. a., and another, ten years after, *5* m. a. In the last case, the perception of light was noticed in the sound eye.

Most changes in the optic nerve and in the retina result in very great impairment of this reaction. The most exact way of applying this test is based upon the secondary reaction. This is a light independent of the colored luminous image and is manifest at the making and breaking of the current, and is produced even when the current is too weak to cause the colored luminous image. In testing this secondary reaction, the intensity of the current is increased until one has produced the primary luminous image—the primary reaction. After this, the current is progressively reduced until it becomes so weak that the making of the current still produces a sensation of light, but the breaking of the current no longer produces any luminous phenomenon. This is the minimum current which Darier calls the "secondary reaction," and it has been found that this secondary reaction in a healthy subject is very uniform, that it is almost always between *1/10* and *3/10* m. a. In a case of advanced diabetic retinitis, with pupillary atrophy, the secondary reaction required a current of at least *8/10* m. a. The same increase in the current required is noticed in cases of old hysteric amaurosis, and in amblyopia exanopsia

As a means of diagnosis, it is of experimental rather than practical interest.

Ear lesions often cause the muscular sound due to faradization to be more distinctly heard than in normal ears.

CHAPTER XVII.

HIGH-FREQUENCY AND X-RAY IN THE TREATMENT OF THE EYE.

THE HIGH-FREQUENCY CURRENT IN OPHTHALMIC PRACTICE.

High-Frequency.—L. Webster Fox, who has made a profound study of the effect of the high-frequency current in eye diseases, cites the following illustrative cases, many of which go to prove what the current will not accomplish:

Fox used a high-frequency coil, with an Oudin resonator and made the application to the lids by a vacuum spiral glass tube and directly to the cornea by glass vacuum eye electrodes for two to twenty

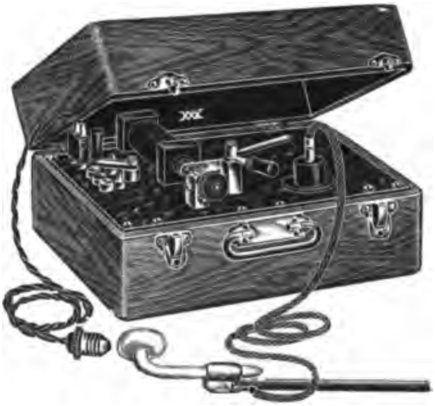


Fig. 112.—Portable High-Frequency Machine.

minutes, three times weekly to daily, and the patient was kept under treatment until assured no benefit could be derived.

Blepharitis Marginalis.—One hundred cases were treated, ten minutes daily for two weeks. The cure was apparently permanent in all.

Granular Lids.—Ten cases. After twenty treatments to the external surface of the lids in each case, there was no benefit.

Ulcers of the Cornea.—Twenty-five cases—all forms from simple to Saemisch. Application was made to the lids and cornea. When there was destructive tissue, the process seemed to be retarded. One case of Saemisch was cured without other aid. The electrode was applied to the cornea, under cocain, in all.

Iritis.—Five cases; three specific, two rheumatic. There was no notable change for the better, but the pain lessened. In one case, ten minutes of treatment gave instant relief, which lasted for three to four hours.

Ophthalmoplegia Interna.—One case. Ten applications were given to the superior cervical sympathetic. No result.

Vitreous Opacities.—Twenty cases, including all forms. Fifty applications were given in some cases. There was some improvement yet not so much as subsequently, under the constant current.

Retinitis Pigmentosa.—Three cases. The fields and vision were slightly improved.

Amblyopia Exanopsia.—Ten cases. A patient, aged *52*, with vision *15/200* was improved to *20/50*, after thirty applications for three to fifteen minutes.

Retinitis Proliferans.—Two cases. Ten applications were made. Little change.

Retinal Hemorrhages.—Ten cases. Eight improved after two to four weeks.

Optic Neuritis.—One case. Not benefited.

Optic Atrophy.—Ten cases. No benefit.

Glaucoma, Chronic.—Five cases. No change produced in tension.

Since the high-frequency current acts as a vasomotor stimulant, and produces, when locally applied, trophic changes, and is not electrolytic, does not cause muscular contraction, or especially stimulate the optic nerve tract, it cannot be expected to clear vitreous opacities, improve paralyzed muscle or restore vision in optic atrophy. The benefit in blepharitis marginalis and corneal ulcers, and in the failure in all the other cases except amblyopia exanopsia and retinal hemorrhage confirm, by clinical experience, what might be anticipated from the physiological effects of the current; and Fox has rendered an invaluable service to ophthalmic practice by practically testing the effects of the high-frequency current in these various diseases.

THE HIGH-FREQUENCY CURRENT FOR LOCAL THERAPEUTIC APPLICATION.

Albert C. Geyser, of New York, writes: If an electric current is to be judged by its therapeutic results, there is no current known today that can even favorably compare with the modern high-frequency current.

In all kinds of chronic skin affections, the high-frequency currents, applied by means of the glass vacuum electrodes, yield more uniformly good results than any other measure known.

Trachoma.—The high-frequency current, applied through a glass vacuum electrode over the closed eyelid, is a revelation to both physician and patient. A ten-minute treatment, every day for one week; tri-weekly for two or three weeks, will usually clear up the most stubborn case.

Tonsilitis.—Either a glass electrode may be applied to the tonsil or a sponge covered metallic electrode may be placed over the outside of each tonsil. Either current should be as hot as the patient can bear. The application should be continued for six minutes, once or oftener daily. Or, a high-frequency spark. by means of a fine wire, is applied to the tonsil. Five or six applications usually bring a return to the normal.

Chronic Catarrh of the Nose.—Nasal catarrh, atrophic or hypertrophic, is practically cured after twelve or fifteen treatments. The glass vacuum electrode is inserted into the nose as far back as possible and a spark gap of one-eighth to one-quarter inch used for five minutes on each side. First, clear the nose with an alcohol spray, and follow the sparking with a spray of petrogen and iodine, five per cent.

Warts and Nevi.—If superficial, these are treated more successfully with the high-frequency current than with any other means. I have constructed for these cases a glass sleeve which is put in contact with the skin. The other part is a movable piston, terminating in a metal point. The hottest current must be used with a one-eighth inch spark gap. Begin the sparking at an inch. A local anesthesia will occur in a few seconds; then, allow the metal to approach the skin and remain at one-eighth of an inch for a second. This should be repeated four to six times as desired.

Neuritis, neuralgia and myalgia are positively relieved with the glass vacuum electrode and frequently in one or two treatments.

Monell is another enthusiastic advocate of the high-frequency current, and cites cases of various types in proof of its efficacy:

Case *1*. Exophthalmic Goitre. Mrs. —, aged *46*, came June *3*, *1903*. Nervous, marked exophthalmos; pulse, *115*; thyroid moderately enlarged; loss of weight, *40* pounds.

Treatment.—Half-inch sparks up and down the spine for ten minutes, and over goitre for two minutes; also, mild one-minute applications directly to each eye, three times a week for four weeks. X-ray exposures with medium tube for ten minutes, at fifteen inches. Later, this was reduced to ten inches.

Two months later the patient had gained fifteen pounds; pulse was normal; she was in best of health and there was no trace of goitre. In *1908* she has had no return of the trouble.

Case *2.* Mrs. —, aged *36.* Has moderate enlargement of the thyroid of one year's duration. Conspicuous exophthalmos; extreme debility.

Treatment.—The same as in case *1*, for seven weeks.

Five months later, the goitre is not visible, but there is evident palpitation. Still improving; is in established health, doing her work and feeling better than in years.

Case *3.* May *4, 1907.* Miss —, aged *53.* Marked debility; unable to go about; eyes proturberant; thyroid moderately enlarged; emaciation.

Treatment.—As before, but stopped prematurely.

September *15.* She reported continued improvement and very good health. Moderate exopthalmos.

Case *5.* Mrs. —, aged *50.* October *5, 1905.*

History of physical collapse; acts like a maniac: eyes markedly protuberant; thyroid hypertrophied to a high degree. Treatment.—Three times weekly for four weeks interruptedly, then twice weekly for ten weeks. Pulse had been *200*; it dropped fifty beats after the first treatment, declined steadily afterwards, with sudden drops after each seance. The eyes, the mental and general condition improved from the first; weight advanced. Two years later she remains in the best of health.

We doubt if medical literature contains any other report of any other remedies equalling the actions produced in the above cases.

Port Wine Marks.—Treated with the high-frequency current. There is a deep red patch an inch in diameter on the cheek. The cautery and electrolysis had failed. I next used a metallic point electrode with insulated handle and connected with the top of the resonator. The point was held one inch from the surface and intermittently applied for several minutes until vesication was produced over the whole patch. In eight days, the epidermis peeled off and left normal skin.

In another case, I used a glass vacuum electrode at half an inch from the skin. The method is more comfortable, but less efficient and takes longer. The result was successful.

Nevus.—A nevus under treatment extends over the side of the neck, cheek, orbit side of nose and upper lip; a vivid red, only partly removed by pressure; too extensive to attempt by any other measure.

In those parts which have been, so far, treated twice, with time for each reaction to subside, the redness is reduced by at least one-half. Possibly, after a third treatment, it will no longer constitute a serious disfigurement. The normal texture of the skin is unimpaired and there is no scar, thus differing from the result of electrolysis.

Opacities in the Vitreous.—The left eye suddenly became blind. There is hemorrhage in the vitreous. The appearance of the vitreous resembled a handful of mud thrown into clear water.

I applied the high-frequency, with vacuum tube over the lids for three to four minutes, three times a week at first, then once a week. Rapid improvement took place and the vision was normal at the end of two months. No return after five months.

I prefer a tube sufficiently high to produce a blue luminosity instead of the low red or pink vacuum.

The particular form of high-frequency discharge known as fulguration is useful in acute and chronic suppurative conditions and in inflammation of the middle ear.

Optic Neuritis.—Dr. B. I had a case which had been treated by other methods for three months without result. With the high-frequency current, I gave six to ten minute applications every other day and completely relieved the neuritis in two months.

Iritis.—Dr. W. has not seen a case of iritis that was not favorably affected by high-frequency treatment.

In one case of rheumatic iritis, the pain was so severe that the patient had not slept for two nights. The high-frequency vacuum tube discharge with a flat electrode attached to the negative pole was applied to the closed lids. It gave such complete relief that the patient fell asleep while being treated and recovery from the attack was rapid.

She had been subject to recurrences, but since this treatment, she has had no recurrence.

Riddell, of Edinburg, asserts that most forms of neuritis are benefited by application of the high-frequency current. He cites the following case:

Mrs. C., aged *30*, complained of supra-orbital neuralgia of thirteen years' duration. There were seldom more than a few days between the attacks. Drugs had given no permanent relief. Treatment with the high-frequency was begun in *1903*, and within six weeks the neuralgia was gone. A month later she struck her head and the neuralgia returned and was removed by a repetition of the treatment. No recurrence in three months.

Dr. F. R. Cook, of New York, sees great possibilities in the high-frequency metallic discharge. He writes: Recently Dr. Keating-Hart demonstrated a new treatment for the eradication of cancer. The method is described as fulguration and consists in the application of electric sparks from an insulated probe, charged with a high-frequency current of considerable voltage, to a malignant growth, after which, the growth is alleged to have softened and finally vanished by volatilization. It differs from the electrolytic action of galvanism, in that it is more powerful, more rapid and affects a much wider area of tissue; it also appears to have a peculiar selective action on morbid cells as well as a stimulating action on normal cells.

Its application to hypertrophied and morbid tonsils is practically painless, causes the tonsils to shrink and rapidly undergo degenerative changes, and is followed in from three to five days by complete exfoliation. In soft and moderately enlarged tonsils, complete reduction is readily accomplished at one sitting. In aggravated cases, it is better, on account of the reaction, to divide the operation into a number of sittings.

Very satisfactory results are obtained in the *removal of scars.*

Fulguration Discharges.—Wm. Harvey King writes as follows:

The term fulguration discharge is applied to the monopolar discharge from the metal point of a Tesla transformer, or from an Oudin resonator. The discharge differs in no respect from that used to energize a vacuum glass electrode, but when concentrated on a metal point it differs very greatly in action. Two methods are in vogue. One is the moist and the other is the dry. By the Keating-Hart method, commonly called the French, water is kept flowing through the electrode during the application. By the dry method, there is not only an absence of moisture, but the part treated is wiped dry.

There is a primary and secondary effect of fulguration, depending upon the duration and severity of the application. It is possible to produce a blanching of the parts ionized, causing destruction of certain cells, changing the color of pigmented spots and stimulating new growth without producing any appreciable necrosis of tissue. On the other hand, it is very easy to produce necrosis. The necrosed tissue becomes a dry, hard mass, without any ulceration or pus; the dry incrustation remains for a time and when it comes off leaves a smooth healed surface. With the blanching action, there is never any scar; and, when necrosis is produced, the scar is usually invisible.

The blanching effect is more easily controlled by the wet method. For destruction by necrosis, I prefer the dry method. Perhaps the necrosis is due to a combination of heat, ionization and ozonization. That the discharge is aseptic is proved by the fact that there is an entire absence of pus, no matter how great the area of destroyed tissue may be.

I have treated five cases of lupus vulgaris and one of rodent ulcer and all have been rapidly and perfectly healed. On the face, it is possible, by two or three blanching treatments, to leave no perceptible scar.

For the removal of nevi, this method far surpasses electrolysis or any other method with which I am acquainted.

Several cases of adenoids have been reported as successfully treated by fulguration discharges.

Technic.—The length of the discharge should be carefully gauged by the withdrawal of the metal point to the distance required within the glass tube. For blanching, about one thirty-second of an inch will be required; for necrosis, one-sixteenth; and, when very deep action is required, one-eighth to one-quarter of an inch. The applications are often not more than three or four seconds, and, in my own experience, never more than thirty.

THE USE OF HIGH-FREQUENCY CURRENT IN DISEASES OF THE EYE.

According to Billinkin, all forms of conjunctivitis recover by the effluve of high-frequency. The number of seances varies from ten to forty-five, according to the chronicity of the affection, but there is always an amelioration in five to six seances. The photophobia of blepharospasm disappears as by enchantment in a few treatments. If the cornea participates in the affection, the effluve directed to the diseased spots rapidly restores them, without leaving any blemish as there is after medication.

In twenty-five cases, Billinkin observed four recurrences; one in one month, two in six months, and one in nine months. These recurrences are not grave if the patient submits at the proper time to treatment. Six seances are sufficient to re-establish a good condition.

Follicular conjunctivitis is still more benefited by effluve. The number of seances is about fifteen to twenty-four and treatment is given every second day.

In two cases of trachoma, Billinkin has obtained two notable ameliorations, without complete recovery, in twenty seances.

Obstinate chalazion yields quickly; five to six seances with high-frequency usually suffice.

Meibomian acne recovers, but necessitates prolonged treatment. Thirty seances of five minutes.

In all, the esthetic result is perfect.

Leprince writes: "The effluvation of high-frequency appears destined to replace static effluve."

He finds, that in typical eczema, the itching disappears in two to three treatments; the secretion and the erythema lessen. The results are less brilliant in eczema sicca.

Oudin recommends first the effluve, then, after the disappearance ot the itching, the application of sparking. The treatments should be daily to tri-weekly.

X-RAY IN THE TREATMENT OF EXTERNAL DISEASES OF THE EYE.

John Green, Jr., writing of the *x*-ray, summarizes its value in the treatment of external diseases of the eye, as follows:

1. In epithelioma and rodent ulcer of the eyelid, radiotherapy surpasses all other methods of treatment.

2. In selected cases of trachoma, radiotherapy offers the possibility of rapid cure, and with a minimum of deformity to the lid.

3. The method is worthy of trial in cases of vernal conjunctivitis, tuberculosis of the conjunctiva, orbital sarcoma, and in recurrence of glioma after operation for glioma of the retina.

4. The treatment is without danger to the function of sight.

CHAPTER XVIII.

PERSONAL COMMUNICATIONS.

ELECTRICITY IN MINOR SURGICAL AFFECTIONS OF THE EYE.

A personal communication from Dr. Howard N. Lyon, of Chicago:

A somewhat extensive experience in the use of electricity in the removal of facial blemishes early led me to adopt this agent in preference to the knife in the treatment of certain of the minor surgical affections of the eye and its appendages. The results of this procedure have been so uniformly successful that I no longer regard these cases as belonging to the surgical category, but rather as ordinary office treatment cases.

For surgical purposes, we may employ either the electro-cautery or the equally effective and more satisfactory agent, electrolysis. In my earlier work, I made frequent use of the electro-cautery, and it is still a valuable agent when available; the difficulty of keeping the apparatus in order, however, is such that I should not advise its use for occasional purposes. In my hands, however, it has been of decided value in trachoma, other granular conditions, and in corneal ulcer. In the treatment of these conditions, the jointed electrode is used at a white heat and the granulation quickly touched or the base of the ulcer lightly brushed over. Considerable experience is necessary before the cautery can be safely used, as the heat is carried by convection or radiation further than the actual point of application, and more extensive destruction of tissue follows than is intended. In skilled hands, the electro-cautery is capable of rendering signal service wherever a powerful and deep-acting caustic is required, but as such conditions are rare about the eyes, I prefer electrolysis for all ordinary purposes.

In electrolysis, we have an agent under absolute control, and whose radius of action is limited to the immediate field of operation, so that, with any reasonable degree of care, it is free from any undesirable effects. A current suitable for electrolysis, in eye cases, may be obtained from any one of the many forms of galvanic batteries or wall plates supplied by the instrument houses, or a half dozen dry cells can be installed in any convenient drawer and wires run to a six-joint switch accessible to the operator's hand. A needle holder, some fine needles, a flat sponge electrode and the necessary conducting cords are all that is needed otherwise. In place of sewing needles, I prefer the fine Swiss broaches used by watchmakers and ground down to suit my needs, but the former serve every purpose. The technique is simple; all that is necessary is to place the moistened sponge on the cheek or other suitable place, and to insert the needle, attached to the negative cord, into the tissue to be acted upon. Then one or more cells of the battery are to be switched on until small bubbles of gas appear about the needle and the tissue surrounding it begins to blanch. Ordinarily, a current of from one to two milliamperes will be sufficient, and each application will seldom require more than one to two minutes. If much tissue is to be acted upon, repeated punctures should be made at sufficient distance from one another to prevent the wounds coalescing. At a subsequent seance, the intervening areas may be treated if necessary. While I have mentioned the volume of current employed, a meter is not necessary, as the current must in every instance be determined by the effect produced on the patient and not by any arbitrary rule of dosage other than that already mentioned: the production of gas and blanching.

Among the conditions I have successfully treated by this method—electrolysis—may be mentioned vascular naevi, both superficial and cavernous, of all sizes, from that of the mere pin point to those involving the entire lid or even a part of the face; milium; pedunculated and sessile warts; ptosis, due to laxity of the tissues; trachoma; hypertrophied papillae of the palpebral conjunctiva; occlusion of the ducts of the puncta (subsequent probing is here necessary in order to keep the passage thus formed from uniting); phlyctenular conjunctivitis and keratitis; pterygium and, in fact, the general list of troubles consequent on either increased vascularization or simple hypertrophy.

In vascular troubles, I prefer to introduce the needle lengthwise into the vessel I wish to obliterate and to carry the treatment to the point of pronounced ischemia. By this means, the enlarged vessels often seen in the conjunctiva can be successfully reduced and the annoyance of a chronic congestion be overcome. In like manner, a sty or similar abscess may be punctured and the contents sterilized. A probe-pointed needle is best for this purpose and can readily be passed down the hair follicle. Trichiasis may be treated by inserting the needle below and parallel to the lid margin, or the offending hairs may be destroyed by the probe-pointed needle; and that still more distressing condition distichiasis may be forever removed by the needle carried to the base of each hair.

Aside from the mere fact that by means of electrolysis, we may do many of the operations usually done with the knife, there is another and greater feature to commend its use and that is, that, by multiple punctures and fractional applications, we may produce the destruction we desire and yet cause no contraction of the surrounding tissues. There may be other methods of removing xanthelasmata than by means of the needle, but I know of none that would not either leave a disfiguring scar or produce so much contraction as to incur the danger of ectropion. I would caution the beginner to go slowly and make frequent applications rather than to attempt too much at a single seance.

Although the text-books on electro-therapeutics make a distinction between the effects of the positive and the negative pole, it is an academic rather than a clinical distinction, and I am unable to find any difference in the effects when mild currents are used for short periods of time. Actual decomposition is produced, it is true, but the resulting ions both positive and negative, remain in the tissue destroyed, the interval being too short to permit of appreciable migration. If the operator, however, prefers the positive pole, it is necessary that the needle be of platinum or gold, as the acid elements will gather on the needle, and, if a steel needle is used, oxidation will result and an indelible deposit of ferrous-ferric oxide will occur.

As a final word, I may mention the fact that electrolysis, when used as I have described, is absolutely free from the danger of subsequent infection, as it effectively sterilizes the tissues surrounding the needle.

In a p. c., Dr. C. Gurnee Fellows, of Chicago, writes his estimate of various electrical modalities, illustrating with cases:

The Sinusoidal Current in Eye Work.—Cases of mild exophoria with weak adduction and fusion faculty, when the vision is normal or corrected by proper glasses, but when the eyes tire after a small amount of close work, are materially helped by a few treatments of sinusoidal electricity.

The Faradic current may as well be given under similar circumstances, but the sinusoidal seems more soothing and less irritating.

A few cases of asthenopia may be stimulated by electrical treatment, sinusoidal or faradic preferably; and I believe that experience with a great number of cases has taught me that results have been obtained that were not due to any correction of a refractive error.

The High-Frequency Current.—The high-frequency current is applied principally for local effect in the relief of pain of a neuralgic type and is often prompt in its action.

X-ray Flashes.—Its use, with fifty to one hundred flashes per minute, is indicated in glaucoma, in trachoma, and in malignant diseases,—lupus and epithelioma of the lids, and in various diseases of the fundus.

A remarkable choroiditis, treated for two years by classical treatment, with considerable progression of the disease, was not only checked, but marvellously improved by the use of the *x*-rays.

The *500* c. p. lamp proved of great service in a case of streptococcus infection, that had resisted Arg. Nit. The patient was astonished at the result of three treatments.

Corneal ulcers are stimulated to quicker healing and pain is greatly relieved by ten or fifteen minutes of treatment with the therapeutic lamp with the blue screen.

The use of the therapeutic lamp in inflammations of the vitreous and retina, when used in mild dosage is often very beneficial. A man, who had lost one eye by enucleation, had an extravasation of blood in the remaining eye, which was entirely absorbed with the use of the lamp, and the eye is still useful, five years afterwards.

Case *1*. Miss H. J. came to my office on October *2*, *1911*. She had had a growth on the lower lid of the left eye for a year and a half; had had it cauterized several times without improvement. She had one *x*-ray treatment and twelve high-frequency treatments. At the end of that time, in two months, the lid was entirely healed and nearly smooth.

Case *2*. Mrs. J. D. S. was examined on October *27*. She was unable to use her eyes at all for reading or sewing. She had worn glasses about twelve years. Glasses were prescribed with no particular relief. There was a weak condition of the external muscles, which showed in a slight exophoria for distance and weak fusion for the near point.

Four treatments with the sinusoidal current, a week apart, have given her relief so that she is now able to read and sew to a moderate extent, without any eye symptoms.

Mrs. W. H. P. came to me November *6*, *1909*. She was *42* years of age. Vision in R. E. = *8/100*; in L. E. = *3/100*. She had been taking the iodides. I made a diagnosis of choroiditis. There had evidently been a recent hemorrhage in the right eye.

I prescribed treatment by the interrupted *x*-ray, one hundred and twenty flashes for a minute and a half. She came for treatment twice a week for a month; once a week for another month; then once a month for three months. At the end of that time her vision was *23/40*.

In March, *1911*, she is reading magazines.

Dr. George, of Chicago, in a personal communication, gives some notes in regard to his personal experience in the use of electricity:

Leucodescent Light for the Treatment of Corneal Ulcer.—Evert the upper lid, apply yellow oxide ointment, grains four to the ounce; revert the lid, gently massage the eye for five minutes, then apply daily the leucodescent light, of fifty to one hundred candlepower, as hot as can be borne, for ten minutes, with the ointment enclosed in the conjunctival sac; after which, apply a compress bandage. When the heat is too intense, the patient may stroke the lid.

The Sinusoidal Current for Paralysis of the Ocular Muscle.—A special round metal electrode, covered with cotton and then with chamois, making the electrode when finished about one-half inch in diameter, should be applied over the insertion of each muscle on the lid; the other pole being held in the hand and the current given as strong as can be tolerated. The seance should be from five to ten minutes, daily or tri-weekly. For paralysis of the facial nerve, a large electrode should be used. In cases of moderate degree, due to exposure, the diplopia is often temporarily relieved by one treatment, and finally, all recover.

The Sinusoidal Current for Sclerosis of the Middle Ear.—In recent cases, which have not yielded to Hydrarg., electricity is found effective. A special electrode is constructed from a metal stethoscope with metal points one-half inch in length to be inserted in the auditory canals. These points are to be covered with chamois skin and moistened when used. The points should be insulated from the metal tubes and should have sockets for the connection of the poles on the opposite end of the stethoscope.. When the electrodes are inserted in the auditory canal and each is connected to a separate pole, there will be an alternating contraction and relaxation of the tissues within the tympanic cavities, as well as a nerve stimulation to both ears. The strength of the current should be as much as the patient can endure. The treatment should be from ten to fifteen minutes, once to three times weekly.

Negative Galvanism in Descemetitis.—An electrode covered with a large amount of cotton so as to cover a considerable area, say four inches in diameter, is applied to the eye and the positive pole is held in the hand. Ten m .a. of current should be given for ten minutes.

High-frequency current in Tinnitus, as a result of a slight congestion or an acute otitis media. The vacuum electrode should be placed at the junction of the auricle and mastoid, for ten to fifteen minutes tri-weekly, and sufficient current used to cause a skin irritation.

The High-Frequency Current in Blepharitis Marginalis.—Use a double ocular vacuum tube. Ten minutes treatment should be given every other day.

Morton Wave Current in Supraorbital Neuralgia.—For ciliary neuralgia, the high-frequency current has not given me the results that the Morton wave has. The Morton wave current is the most effective treatment for ciliary neuralgia that I have found. It seems to be a specific for the disease. The method of applying it is with a double eye sponge electrode attached to a hard rubber handle. The sponges are to be moist and held against the eyes and the current should be as strong as can be borne. The treatment should last from ten to fifteen minutes and be repeated every day until the pain is relieved.

The Morton Wave Current can be obtained from the high-frequency coil as well as from the Static machine.

Part IV.

Electricity in Diseases of the Ear.

CHAPTER I.

THE EXTERNAL AND MIDDLE EAR.

STRICTURE OF THE EXTERNAL AUDITORY CANAL.

Robert Barclay operated with the trephine upon a case of bony stricture, in which there was an ivory-like exotosis, which almost completely occluded the meatus. The operation was thoroughly successful.

In connective tissue, strictures may be treated by electrolysis, by placing the negative electrode in the ear and the positive to the mastoid. Or, insert a bipolar needle into the tissue.

Ostmann treated, successfully, a nearly closed meatus, with a suppurating middle ear, by thrusting two needles through the upper part of the base of the stricture, with five m. a. for five minutes. Three other treatments, given during the month completed the cure.

FURUNCLES.

I have found that furuncles, in the early stages, yield promptly. To abort furuncles, Reich uses air, heated to *100°* to *120°* C., applied two or three times the first day and daily thereafter; and states that positive results are obtained by this treatment. In no case, where the treatment was begun early, did suppuration or tissue necrosis take place. The hot air reduces the virulence of the staphylococci and the hyperemia and brings about a rapid absorption of the infiltration. Reinfection of the tissue surrounding the boil never occurs.

Marcus, before the period for suppuration, introduces the negative epilation needle, with one to two m. a. gradually increased to ten m. a. The needle is, in a short time, removed, the spot cleansed; then the positive pole, connected with the needle, is gradually given ten m. a. for two to three minutes.

THE USE OF THE PHONOGRAPH IN HEARING.

Dr. George F. Fiske, of Chicago, in a personal communication on this subject says: "I used the phonograph from about *1896* to *1899*, in making records, thinking it would be very exact (which it was), and thinking it would take the place of the human voice—which I consider the one really valuable test —but it does not take the place of the voice; for that reason I gave it up. When the test words and sentences are spoken into the phonograph, the quality reproduced is entirely different from the voice, particularly in regard to pitch—and your test then resolves itself into a test where you use high notes, like the watch or acoumeter."

A Phonographic Acoumeter.—Bryant, of New York, says: "Its advantage is that the voice, produced by the machine, has a constant pitch and intensity; while the intensity can be varied from zero to the loudness of the voice when the speaking-tube is used.

Simulated deafness can be detected by turning the sound off and on, or rapidly alternating, so that the patient becomes so distracted as to prevent replies consistent with any considerable degree of real deafness."

A New Phonometer.—A Lucae says: "By means of this new instrument, even a whisper can be measured, and the loudness of the voice by means of the excursion of an indicator.''

Dench writes: ''The instruments devised as tests of hearing are often complicated. The phonograph, supplied with a series of standard cylinders and capable of reproducing sounds which shall always be uniform in pitch and intensity, is probably the most simple of the devices.''

CHRONIC NON-SUPPURATIVE OTITIS MEDIA.

In chronic non-suppurative otitis media, the eustachian tube is generally patent; the membrana tympani is more or less fixed; and there is often anchylosis of the stapes. Therefore the customary inflation of the tube is usually futile.

Literature in regard to the electrolysis of the tube is very voluminous, but, in my experience, stenosis of the tube is so rare that treatment by electrolysis is seldom required. When electrolysis is successfully used, the whole credit is attributed to the rendering of the tube patent; whereas, it must be remembered that it is impossible to apply a current to the tube without having it reach the middle and internal ear, which are thereby directly benefited.

All the conditions seem to me to indicate generally the necessity of the application of the alternating, the high-frequency or the direct current.

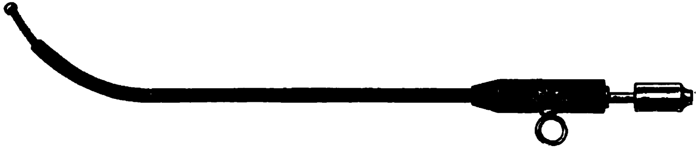


Fig. 113.—Eustachian Electrode.

Until recently, I applied the eustachian electrode to the mouth of the tube and a sponge electrode to the ear. Now, in applying the alternating current, I drop warm water into the ears, then insert cones of moistened cotton, and over them place moist cotton pads, and bring an electrode in contact with each pad, with as strong a current as the patient will tolerate, for ten minutes daily.

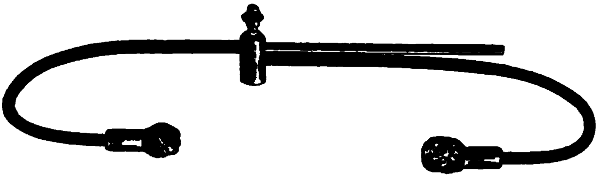


Fig. 114.—Binaural Electrode for Alternating or Direct Current.

In the use of the high-frequency current, I apply a binaural electrode to each pad and connect the electrodes by a single cord to the positive prime conductor of the high-frequency coil, and secure contraction of the tensor tympani muscle by placing a rheotome in the electric circuit—applying two to four hundred interruptions per minute—and treating the patient daily for ten minutes.

Of these two currents, I cannot say which is the more effective, yet the fact remains that one may produce beneficial results after the other has failed.

Case *1*. Rev. S. J. W. consulted me September *14*, *1904*. His hearing has been failing for eighteen years; constant drumming tinnitus. Has had dry catarrh for twenty years till four years ago, when the turbinates were removed.

Hearing Distance: R. E. = conversation at twelve feet. L. E. = conversation at six inches. R. E. Rinné +, L. E. Rinné —. Membranes appear normal. Chronic sclerosis of middle ear. Fork on vortex—heard the same with either ear. Is constantly obliged to ask people to repeat their remarks.

Treatment: Muscular contraction current from high-frequency coil, with binaural electrode in the ears, for ten minutes tri-weekly.

Six weeks later, he says his hearing is all right; never has to ask people to repeat what they say, and now hears a clock tick twenty-five to thirty feet distant, which he could not do previously.

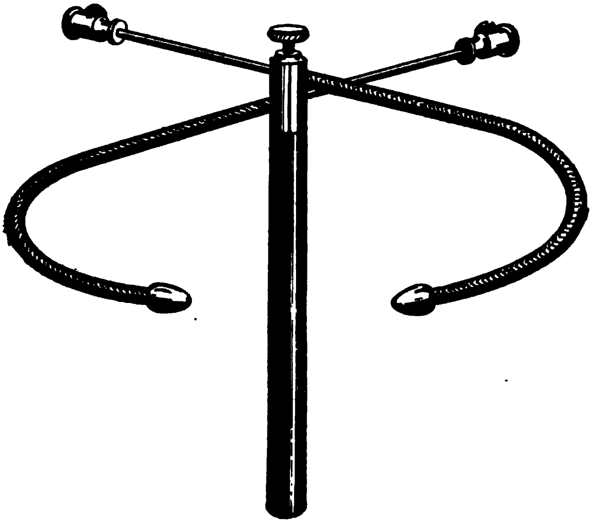


Fig. 115.—Cook Bipolar H. F. Ear Electrode.

Case *2*, in which the hearing was greatly improved by the application of the alternating current to the ears.

Miss L., aged *15*, has been treated by Dr. Gradle for one year. She later consulted me and received treatment for one year with aural pneumatic massage (with the ear pump) of the membrana tympani, etc., without any improvement in hearing. The patient can distinguish ordinary conversation when the speaker is close to her ear. The watch is not heard in contact. The membranes appear normal; the tubes patent.

℞. The tips of a binaural electrode were applied to moistened cotton plugs in the ears, and an alternating current applied for ten minutes daily.

After three months, each ear could hear the ordinary conversational voice at twelve feet. Five years later, the hearing remained equally good.

Case *3*. Mrs. B., aged *33*, consulted me January *2, 1908*. Has had impaired hearing since *1899*. She hears better in a noise; tinnitus. Nasal obstruction and was operated on in *1905*. Hearing distance, R. E. = forced whisper at eight feet. With left ear, the same.

Membrana tympani,—both are opaque and present very small bright spots and are retracted. Rinné minus. Valsalva well felt. Had had treatment previously for two and a half years, tri-weekly, then weekly, with catherization, without improvement.

Treatment.—Muscular contraction current from the high-frequency coil for ten minutes daily to the ears.

January *28*, R. E. hears forced whisper at eight feet; L. at twenty feet.

℞. Alternating current to the ears for fifteen minutes daily.

February *28*,—the hearing had improved so that she could distinguish words in a forced whisper at twenty feet.

Case *4*. S., aged *60*, consulted me February *15, 1908*. The left ear is very defective, noticeably in using the phone. The membrana tympani opaque white; bright spot small; hears ordinary conversation at four feet only. The watch is heard only when in contact with the ear.

℞. Vibrator to the left mastoid for three minutes daily in February and tri-weekly in March.

March *30*. He can hear ordinary conversation at eighteen feet and the watch at one inch.

Dr. Ridell, of Glasgow, writes of treating dullness of hearing and subjective noises in the ears by high-frequency currents. He reports thirty-two cases, which he separates into four classes, noting results.

Class *1*. Chronic dry catarrh of the middle ear, with labyrinth involvement. Six patients treated. No improvement in any, but two thought the noise had decreased.

Class *2*. Chronic middle ear catarrh, without labyrinth involvement. Ten had tinnitus; eight improved. In one case, the tinnitus disappeared. Improvement in hearing in two cases.

Class *3*. Post-suppurative conditions with tinnitus. Five cases. In four, the tinnitus improved.

Class *4*. Sclerosis of the middle ear, with tinnitus. Five cases. The tinnitus improved markedly in three cases, slightly in two. In one case, with persistent tinnitus for four years, there has been no noise for four months.

The patients were treated locally and generally. Locally (*1*), by the resonator applied, without sparking, to the side of the head.

(*2*) By electrodes to each end of the solenoid, and introduced into the external auditory canal.

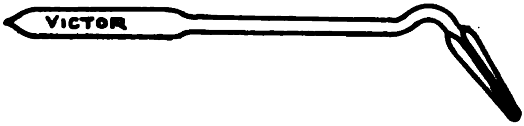


Fig. 116.—High-Frequency Ear Electrode.

Eberhart, of Chicago, considers that the high-frequency currents give the best results in catarrhal deafness, earache, tinnitus aurium, and chronic suppurative otitis media. He offers the following technic: In applying a current to the ear, a small glass vacuum insulated tube is employed most conveniently in a movable socket handle,—such as the writer has designed. The tube is placed at an angle in the handle. The current is gradually increased to the tolerance of the patient, to the point where the buzzing becomes annoying or the fine sparks become too sharp. The tube is allowed to remain until the heat becomes a little uncomfortable, but not longer than seven minutes.

Urbantschitsch, in treating impaired hearing, resulting from purulent and non-purulent otitis media, uses a screw-like negative electrode, wound with moist cotton, in the ear, with one-tenth to two-tenths m. a. of current. He finds that more produces pain and dizziness.

He reports ten cases, eighteen ears, some having been previously treated for months. In six ears, there was an improvement—either of hearing, or of noises, or both. In all cases, the ordinary methods were without results.

Politzer writes that his experience shows that

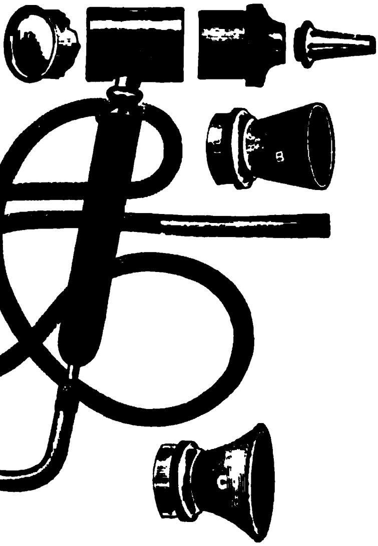


Fig. 117.—Pneumo-Massage Attachment to be used with any Ear Pump.

permanent improvement in the hearing and complete removal of the subjective noises are obtained in only rare cases by the galvanic treatment; yet it not infrequently diminishes the tinnitus and the heaviness, pressure, dizziness and stupor, which often accompany aural affections.

Politzer finds that pneumo-massage occasions, in many cases, not only a decided improvement in hearing, but also a temporary or permanent diminution in the subjective noises, and exercises a decided benefit upon the head symptoms, which are not infrequently entirely cured. Sometimes one observes an increase in the noises and dizziness and diminution of hearing.

Dr. Thomas Barr says that pneumo-massage, by means of an electric oto-massage apparatus, is called for when there is a retracted membrane, along with adhesions; or, where there is rigidity of the ossicles or fixation of the stapes. Tinnitus, he finds, is often relieved by this method even when the hearing is not improved.

Pain, he says, is not unfrequently complained of in the ear, when no inflammation is present. Galvanism may remove a neuralgia which has resisted every other method of treatment.

Prof. Ostman, writing of vibratory massage in chronic deafness, concludes that it is contraindicated in all diseases of the sound perceiving apparatus with sound conduction. If, however, rigidity of the ossicles exists, it would be well to try the massage. It would seem that massage is of little benefit when the ossicles are retracted, when there is a simple chronic middle ear catarrh, or when there is extensive atrophy of the tympani.

Operative Treatment. Packard writes: The galvano-cautery has superseded all other methods of perforating the membrana tympani in catarrhal otitis media. The results are so unsatisfactory, however, that there are now few advocates of the procedure.

OTOSCLEROSIS.

Zitowitsch reports twenty cases of otosclerosis treated with the faradic current. With one or two exceptions, all the cases show increase in hearing and decreased tinnitus. One electrode should be introduced into the mouth of the eustachian tube, the other placed between the jaw and the mastoid. The treatment should last for three to five minutes, and be repeated tri-weekly, with as strong a current as can be borne.

Dr. Philip D. Kerrison, of New York, writing of otosclerosis, says that the results of treatment are not encouraging. "The prediction of Politzer that the deafness occurring in the advanced stages of the disease will remain forever beyond the ability of the otologist to cure, is one which few, at the present time, will care to contradict."

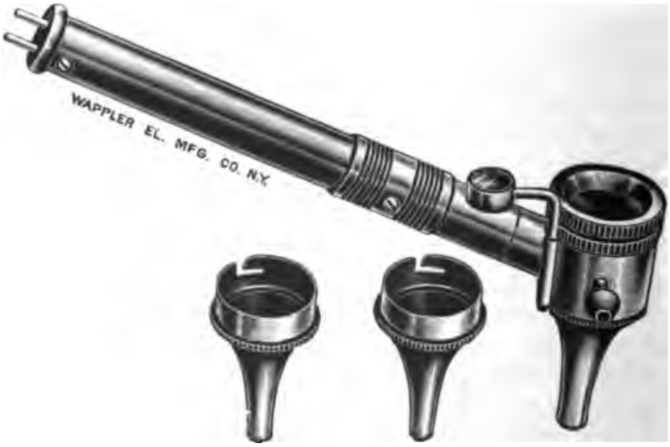


Fig. 118.—Electric Otoscope.

OTALGIA.

In otalgia, especially after acute inflammations, a strong faradic current, lasting about three minutes, is useful. (Urbantschitsch.)

INCISION OF THE MEMBRANA TYMPANI.

Ballenger, of Chicago, advocates using the electro-cautery in adhesive non-inflammatory cases, as the incision remains open longer than when made with a knife. He gives the following technic:

1. Inject 2 per cent cocaine through the catheter into the middle ear.
2. Use an electrode with a bent shank.
3. Employ sufficient current to instantly raise the cautery-point to a bright red.
4. Make contact before turning on the current.
5. Keep in contact for one second.

The perforation of the membrana tympani was first practiced by Voltolini.

Of late, the galvano-cautery has superseded all other methods of producing artificial perforation of the membrana tympani in catarrhal otitis media. The results are so unsatisfactory, however, even when the perforation remains permanently open, that there are now few advocates of the procedure.

MECHANICAL MASSAGE IN THE TREATMENT OF THE NOSE, THROAT AND EAR.

Moreau R. Brown, of Chicago, offers the following technic: For ear, nasal or laryngeal vibrassage, the vibrator, generally driven by an electric motor, must be of that type which imparts a circular or wave-like motion, such as is obtained by fastening the vibratode on the end of the handle of either of the instruments referred to below.

In a general way, it may be stated that in using the instrument made by Messrs. Truax, Greene & Co. the weight in the handle should be screwed down to its fullest extent, and that, with the vibrator made by the Victor Co. the weight is turned out to a point where the vibrations are short but distinct, as can be determined by the operator by placing the vibrator against his own face. The pressure must be but moderate and the vibratode should be bell-shaped and made of soft rubber and from one to two inches in diameter, at the distal end.

Massage of the nose, throat, and ear should be begun by treatment of the neck, the vibratode being passed from above downward over the muscles of the back and sides of the neck. The fingers may be used as the vibratode; or a vibrator, giving the hammer-like stroke, may be used with advantage. The patient should be carefully watched during the first few treatments, as approaching syncope has been noticed several times while vibrating over the vagus.

The larynx is treated by gently grasping the thyroid cartilage between the forefinger and thumb, while the vibrator is held firmly like a penholder well up in the crotch between the forefinger and thumb.

In vibrassage of the nose, the soft rubber cup is passed downward over that organ and on the neighboring sides of the face and above on the forehead.

In ear vibrassage, the soft rubber cup is passed downward in front of the ear, then behind the ear and over the mastoid, and over the space between the angle of the jaw and the mastoid; after which, it is placed to cover the auditory meatus. In order to reach the deeper portions of the ear and the eustachian tube, the vibratode must be taken between the finger and thumb and the tip of the finger should be put in the external auditory canal. It is strongly urged that the novice first operate on himself, otherwise he might do his patients irreparable injury.

The duration of the treatment must not be prolonged beyond the point of stimulation to that of exhaustion. The sensations of the patient will generally indicate the limit. For the first treatment of the ear, three minutes is ample time, including that devoted to the neck. The indication for a renewal of the treatment is a return of the symptoms which have been dissipated. In acute disorders, daily treatments are required. In chronic conditions, tri-weekly.

If the symptoms are aggravated, the treatment should be discontinued. If improvement does not follow in three to four weeks, I do not think it advisable to continue it. The shorter the time which has elapsed since the inflammation was acute, the more rapidly will it yield to massage; that is, we can massage away fresher exudate with greater ease than we can the older.

The indications for the use of massage in the nose, throat, and ear are for the relief of neuralgia, rheumatism, paralysis, enlarged glands, which follow some forms of tonsilitis, and acute and chronic non-suppurative inflammatory affections. Its use in diseases of the nose is limited. It will not relieve the nasal stenosis due to turbinal engorgement to the extent reported by Bleyer. In dry rhinitis, it will increase the moisture in the nose and relieve the pain of certain inflammatory disorders. It is indicated in acute pharyngitis; non-suppurative and non-membranous. It is of value in pharyngitis sicco. In pharyngeal paralysis, following inflammation, we have in massage a remedy of unsurpassed value.

Its use in the larynx is limited to some forms of paralysis and to acute and chronic laryngitis.

As to breaking up adhesions of the membrana tympani, and rigidity of the ossicles, vibrassage compares favorably with pneumo-massage. The effect of this latter on the rigid ossicles is not so satisfactory as we are led to expect; nor can we with it massage the middle ear, which is so essential, as can be done with the vibrators; its value therefore is but limited.

Vibratory massage is successfully used for the relief of otalgia, tinnitus aurium, nervous deafness, acute and chronic catarrhal non-suppurative inflammations of the auditory tract, and suppurative otitis media—after the suppuration has ceased. Its benefits are most noticeable in otitis media acuta; and in otitis media chronica, characterized by a full feeling of the ear; tinnitus; etc., impaired hearing.

My records show cases of acute, subacute and chronic otitis media, at times accompanied by marked deafness, and with deficient bone conduction,—some having resisted the generally recommended treatment—which recovered rapidly under mechanical massage.

THE EUSTACHIAN TUBE.

Writing of the value of electrolytic dilation of the eustachian tubes in chronic tubal catarrh and chronic catarrhal otitis media, Dr. A. B. Duel, of New York, says, "To bring about the absorption of the exudates, I use electrolysis. The gold bougies are Nos. *2*, *3* and *4*, of the French scale. The bougie is drawn through a small pure silver catheter until the oval head fits snugly in the opening at the tip. This is connected by a handle with the negative pole of the battery. The catheter is insulated by winding around it a narrow strip of rubber tissue spirally. The positive pole is held in the hand of the patient. The bougie is pushed through the catheter until it meets with an obstruction; then, a current of one to three m.a. is turned on; then, after twenty seconds, to a minute, the bougie will pass through the stricture with gentle pressure. If not, the current should be increased up to *5* m. a. at a sitting. Repeat once weekly to monthly. Two to four sittings are usually sufficient. Some fifty cases are recorded.

All narrow tubes should be restored to their normal calibre, and when the narrowing is due to an organized inflammatory tissue, the best means of accomplishing this is by electrolysis.''

In twenty-five replies to Dr. Duel's letter, two stated that the method, by electrolysis of the tube, had been found of no value; seventeen believed that the tubes could be more quickly opened by electrolysis; nine reported the breaking of the probe in the tube. So confident is the author of the benefit of the treatment, that he would feel compelled to continue its use, even although all the other members abandoned it.

After a year's experience in the treatment of stricture of the eustachian tube, by means of the electric bougie, Dr. T. J. Harris, of New York, writing in *1901*, says: ''In the majority of cases, a silver catheter, wound with thin rubber, had been employed with a negative current of not more than three m.a. for five minutes. Inflation was not practiced afterwards. Of the thirty-three cases, twenty-four had tinnitus of a chronic nature; and, of these, one was cured, thirteen were improved, and twelve were not improved. Only thirteen complained of difficulty in hearing, and of these, twelve were improved. In only two cases, out of twenty-five, was the tinnitus permanently cured.''

Harris was convinced that the electrical current, even when properly used, was capable of causing adhesions of the tube and that the effect of the current in relaxing the stricture was not permanent. Suppuration of the ear had followed the treatment in three cases and mastoiditis in one.

Dr. M. P. Brandegee said that at the New York Infirmary he had noticed a distinct and permanent result in nearly every case treated by this method.

The tinnitus had been greatly benefited and the hearing markedly increased. In one hundred and fifty cases there had been no case of suppuration following this treatment.

Writing in the following year, *1904*, Dr. Harris sums up his conclusions thus: *1.* That there is a certain degree of value in the method, in a relatively small number of cases. *2.* That the method is attended with no small degree of danger from sepsis, traumatic and electrical danger, and should be employed only after every other means of establishing the patency of the tube has been tried and failed. The most scrupulous attention to antisepsis is essential.

Finally—In the majority of cases, the process is not a true electrolytic one.

Wendell C. Phillips says that the electric bougie, advocated by Duel, may be employed whenever the stricture proves unpermeable to the whalebone bougie. It is, he says, a complicated procedure, requiring a galvanic current and an insulated gold bougie. The technique is difficult, and, in a few cases reported, portions of the distal extremity of the bougie have broken off while in the tube. Nevertheless, the electric bougie can be made to overcome strictures which are impermeable to other forms of probing.

I would add a word—Attached to the negative cord a silver or copper bougie will answer as well as one of gold.

Dr. H. B. Crocker, of California, reports that in fourteen cases of tubal deafness treated by this method, each case receiving ten to twenty treatments, only two were benefited to any appreciable extent. The negative electrode with five volts was used. The bougie was slowly passed and followed by a larger one.

Ballenger, of Chicago, says: "It is difficult to overcome cicatricial contractions, especially if due to syphilis. If due to diphtheria and tuberculosis, electrolysis may be of value. An olive-tipped electrode should be introduced through the catheter to the isthmus. Use the negative pole, with five to thirty m.a. for five to twenty minutes. If it is a simple hypertrophy, the positive pole should be used. If the lumen of the tube is constricted further up, a small gold-tipped electrode should be introduced through the catheter, as recommended by A. B. Duel. In some instances, the method will be attended with astonishingly good results. In the hands of most it has been disappointing. The benefits may well be attributed to the dilation and inflation which are incidental to the procedure."

Elwood Matlack, of Philadelphia, reports seventy-five cases. He used this method with every person applying for treatment, who consented.

There were very few cases in which the pathologic changes were confined to the tube. The deafness and tinnitus were almost invariably cured, or at least relieved, in those cases in which the eustachian obstruction seemed to be the cause of the trouble.

Excluding labyrinth disease, Matlack regards electrolysis of service in almost all forms of deafness.

He uses a current of one to five m.a. for one minute, once a week.

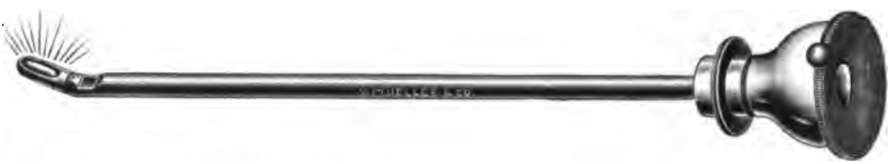


Fig. 119.—Salpingoscope. (Hirschmann-Valentine's.) For the Examination of the Nasal and Pharyngeal Cavities and the Larynx.

Hopkins, of Cleveland, in treating chronic catarrhal deafness, employs an electric compressed air heater.

He has treated sixty-four cases of ankylosis of the stapes with but four failures, and these had labyrinthine involvement. Technic—The ear is cleansed with alcohol; narrow strips of gauze are packed in the ear and a large pad of gauze placed over it. The ear is then covered with a canvas sleeve and air sent into the canal at a temperature which gradually reaches *400°*. The only discomfort that may arise is a severe headache which is promptly relieved by codein. The sleeve should have a perforation near the point of contact with the ear. One ear only is treated on any one day. Treatments are given three

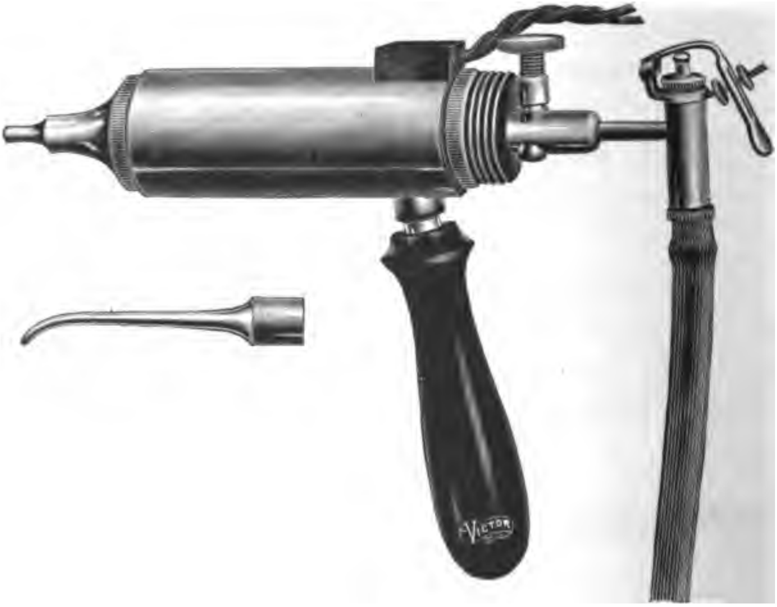


Fig. 120.—Electric Air Heater for Attachment to any Nebulizer.

times weekly for three to twelve months. After the supra-heated air treatment, inflate the eustachian tube with a warm vapor.

Contra-indications — arterio-sclerosis, serous effusions and perforations.

It is doubtful, says Dr. Hopkins, whether one in the whole number treated by this method has perfect hearing, but every patient discharged—since contra-indications have been closely observed—has been perfectly satisfied with the result.

Ferran is also an advocate of Hot Air in otology. His apparatus consists of a simple Politzer bag, prolonged by an aluminum neck, containing an electrical resistance. This is sufficiently light not to make catheterization painful. Cases of otosclerosis have been little benefited, but in cases of tubal catarrh, the results have been far better than by any other method. He reports cases which returned to normal hearing when little improvement had been previously obtained.

ACUTE CATARRHAL AND SUPPURATIVE OTITIS MEDIA TREATED BY THE *500* C. P. LAMP.

Rogers says that the use of the light in the treatment of otitis media frequently produces phenomenal results; but these are confined to the early stage, before the formation of pus; and to the later stage, after the cavity has been evacuated. Not infrequently, the disease will be aborted by a treatment for fifteen to twenty minutes.

Technic.—Apply the *500* c. p. lamp for fifteen minutes and repeat in one-half hour. If pain continues, repeat with the lamp as close to the ear as can be endured.

After the formation of pus the lamp will be of little service, until the membrane has been punctured or opened by necrotic perforation.

Case *2*. Miss B., aged *20*. Had been under the care of Dr. Sauer, of Lena, Ills., for five months, suffering from acute suppurative otitis media which developed into the chronic, purulent form. Under the use of the *500* c. p. lamp, for thirty minutes, twice daily, the discharge ceased on the fourth day, and, in thirty days the patient was discharged cured, and with normal hearing.

CHRONIC PURULENT OTITIS MEDIA.

Mrs. S., aged *60*, consulted me May *24*, *1904*. She has chronic otitis media of the right ear and chronic purulent otitis media of the left ear. The hearing in the left ear was lost in childhood. The hearing in the right ear has been impaired for seven to eight years and is getting worse.

Previous treatment—She has had treatment by an aurist, during the winter months, for past six years without improvement.

Right ear=¼″/12″ (watch)=conversation and forced whisper at three feet. Upper ¼ of membrana tympani has fibrous looking infiltration.

Left ear—Loss of upper half and lower third of membrana tympani.

℞. High-frequency current, with glass vacuum tube in each meatus, daily, for five minutes.

June *15*. Hearing distance right ear ordinary conversation and forced whisper at fifteen to twenty feet. Very slight discharge in left ear.

2. Mrs. R., aged *48*, consulted me December *20*, *1907*. She has purulent otitis media. The left ear has discharged for seven or eight years. I removed a polypus with a cold snare. January, *1908*, treated the patient during the month with *5%* acid chromic. Discharge continues offensive and free. February, treated by *500* c. p. lamp, for twenty minutes, twice weekly. March *6*, no discharge for two weeks past.

Hearing distance=12″ (watch) and hears ordinary conversation at twenty feet.

3. —, aged *63*. Has acute otitis media, with profuse discharge. Severe pain on right side of head and ear for three weeks following grippe; patient could neither eat nor sleep for the past week.

Light from the *500* c. p. lamp was applied to the side of the head for fifteen minutes. Next day the patient said that he had had the first good night's rest in three weeks.

He received six treatments with the result that the pain, inflammation and discharge disappeared and the patient was as well as usual. There was no recurrence.

I do not contend that light will cure all cases, but if it is used in the early stages it will abort the inflammatory condition in most cases. I have also used this light in several cases of inflammation of the accessory sinuses, and with equal success.

Dr. E. D. Brooks, of Ann Arbor, Michigan, advocates cataphoresis in the treatment of suppuration of the middle ear and cites the following illustrative case:

—, aged *24*, had otorrhoea and polypi cured when a child. Nasal catarrh, a few weeks since, brought on again a discharge which was abundant and foul smelling. The ear was syringed with a solution of hydrogen peroxide and filled with a warm solution of bichloride of mercury, *1* to *1000*. The copper tip of the negative cord was wound with cotton and placed in the solution in the ear, and as much current as the patient could bear without discomfort turned on for five minutes. This was repeated daily for four days, with rapid diminution of the discharge, and also of the headache and tenderness of the ear and nervousness.

ELECTRICITY IN THE TREATMENT OF ATROPHIC OTITIS MEDIA.

Albert H. Andrews, of Chicago, in a personal communication, says: The application of electricity to the treatment of chronic catarrhal otitis media is based upon the well-known effect of galvanism upon chronic inflammatory processes. In the atrophic stage, when the connective tissue which was produced in the hypertrophic stage is now contracting, negative galvanism increases the blood supply, softens the connective tissue, brings about its absorption, and, in uncomplicated cases, invariably increases the hearing.

The symptoms of this disease are: Deafness, tinnitus, retraction of the membrane, foreshortening of the malleus handle, interference with excursions of the malleus as seen through the otoscope, lessened air conduction for the tuning fork, and, in patients below middle age, increase in bone conduction.

In order to get the beneficial effect of electricity in the middle ear the current must be made to pass through the drum membrane and the chain of ossicles. It is doubtful if the current passing through the walls of the auditory canal has any appreciable effect upon the tympanic cavity. The drum membrane is exceedingly sensitive to the galvanic current. Hence, the application must be made with great care and it is best to let the patient control the amount of the current, rather than to depend upon the meter. This can be done by regulating the amount of contact between the hand and the sponge electrode.

A small pencil of cotton is rolled on an applicator, which has an eye in the back for receiving the cord tip. A piece of rubber tube, of suitable size, is first put on the applicator. Then the cotton is rolled on and the rubber insulation pushed down almost to the end of the cotton. The cotton is saturated with water or a weak potassium iodide solution and then pushed down against the drum membrane. The cord is brought over the top of the patient's head and the tip inserted in the eye in the applicator. This makes the head carry the weight of the cord, so that it does not drag the electrode out of position. The handle of the contact electrode is held in one hand, while one of the fingers of the other hand is held against the sponge. The operator turns on the current very slowly, telling the patient that as soon as he feels the current in his ear he should immediately remove his hand from the sponge.

As soon as the patient indicates, by removing the hand from the sponge, that he feels the current, he is asked to touch the sponge again very gently, perhaps with only one finger. If no pain is caused in the ear, he can apply two or three fingers, or make firmer pressure on the sponge, until he receives all the current through the ear that he can take without discomfort.

The extreme sensitiveness of the membrane to galvanism is probably due partly to the general sensitiveness and partly to the current passing through the delicate chain of ossicles. A given current passing through the chain of ossicles will be more than a hundred times as strong for the tissue through which it is passing as would be the same current distributed through a square inch of surface.

When the current is measured, it will usually be found that about one-quarter of a milliampere is all the patient will endure. The treatment should be repeated two or three times a week for perhaps a month. Then it should be discontinued for a few weeks and continued again if conditions seem to warrant.

TINNITUS AURIUM.

A. Schloss, of San Francisco, writes: In tinnitus aurium I use a Hopkins' Electric Heater, at a temperature of two to three hundred degrees at a pressure of five to six pounds, for not more than five minutes.

The ear piece is three-sixteenths of an inch in diameter. Technic—First, cleanse the auditory canal then dry with alcohol. Place the ear piece in the external.meatus and direct the air against the tympanum.

I treat my patients three times a week for about eight weeks; and, so far, I have not had a failure among the many cases I have treated. The effect on the deafness has been beneficial.

W. J. Morton, of New York, reports the following case: —, aged 33, cured. Five years ago had a dry throat and was treated by sprays for two years with no benefit. Two years ago the patient had grippe, when tinnitus began.

Present State—Is nervous and has almost constant ringing in the ears, worse in the left ear; sleep is disturbed by the noise, which is worse at night; free post-nasal discharge; slight vertigo; hearing in left ear is considerably impaired.

Treated for a time by the "static induced" current and the sinusoidal, with some amelioration. March 29, 1893, an electric diffusion copper bulb was applied throughout the post-nasal and pharyngeal region with twelve m.a. of current, for five minutes, on each side. April 3, repeat. On April 5 there was no discharge and the tinnitus ceased during the treatment. Repeat. From April 7 to 19, the condition fluctuated and the patient discontinued treatment. May 3, treatment was renewed and electric diffusion was applied to the hypertrophied tonsils and post-nasal region, about every third day, until May 25, when the ringing and catarrhal troubles ceased and the throat became normal. January *30*, *1894*, the patient remains well, in spite of an attack of grippe during the winter.

HEAD NOISES.

Jaques Boyer writes thus of the scientific studies of Dr. Marage, of Paris, in the line of head noises, and of his "Wonderful Machine":

Dr Marage divides these sounds into noises, musical notes and words or vocal cries.

Whistling is the only subjective sound that occurs alone. The whistling sound is caused by the displacement of the stirrup. In order to suppress the whistling it is merely necessary to bring the stirrup gradually back to its normal position. This result can be accomplished by means of sonorous vibrations of small intensity, which displace the stirrup less than one twenty-five thousandth of an inch. For this purpose, Dr. Marage employs synthetic vowel sounds of low pitch, produced by forcing air at low pressure through his well-known siren, which has been described in the Scientific American.

Suppression of the sound of the pulse, associated with disturbances of the general circulation, Dr. Marage has relieved in several patients by a few applications of the alternating current of very high frequency—D'Arsonval currents—to the ear. The currents act upon the vaso-motor nerves, which control the circulation.

For the treatment of the other abnormal sounds, the Doctor employs vibratory massage of the head, at the level of the parietal and temporal bones. This is successful when the trouble is of recent origin. This variety of sound is caused by a persistent excitation of the auditory nerve centres; for instance, the sound of a bell is heard continually, because the element of the nerve fibres and centres, like the filings in a Brauly Coherer maintain the conducting position which they assumed, when the sound of the real bell was last heard.

In a personal communication, on the subject of Sound Waves in the Treatment of Oto-sclerosis, Dr. Howard N. Lyon, of Chicago, writes: In the summer of *1894*, the remark of a manufacturer of surgical appliances that "a hearing horn provided with reeds like a harmonica, would be a valuable aid to the deaf, but that mechanical difficulties had hitherto prevented the production of such apparatus," started me on a line of experiments that were interesting if not profitable. My own studies had already shown that, aside from the presence of tone islands and tone vacancies in the perceptive apparatus of the internal ear, there were corresponding defects in the conducting apparatus of the external and middle regions; and, furthermore, that in certain instances, there was an irregular conduction of sounds; some notes of the piano, for instance, being readily heard, while other notes could only be perceived when loudly sounded. One patient in particular being able to hear only the accented notes of a waltz.

The hearing horn idea I soon dismissed as impractical, but the idea of a series of vibratory reeds proved alluring as a means of exercising the conducting apparatus of the middle ear and thus leading to a better sound conduction, through freeing adhesions and the production of a better circulation in the muscles and ligaments of the ossicles. Furthermore, it seemed possible that there might be a more or less complete regeneration of nerve tissue, as a result of the constant impingement of sound waves on the receptive apparatus. For the purpose of these experiments, I first made use of a telephone receiver, connected in series with an automatic rheotome, adjusted to giving a rate of vibration to the diaphragm of the receiver corresponding to the musical note desired. By this means, I was able to produce a constant succession of sound waves to impinge on the drum head. The apparatus was capable of adjustment through a range covering the three middle octaves. The results, however, were disappointing. The failure I attributed to the fact that the force of the vibrations was insufficient to overcome the sclerosed tissues, and I must need employ something that would give a great volume of tone.

My next experiments were with an auxiliary sound box, attached to the sounding board of a piano, and connected to the auditory apparatus by means of a rubber tube. This proved more hopeful and led to the adoption of a sounding box on the plan of an Aeolian harp, but having only one string. By varying the position of the bridge, and picking the string with a plectrum, I could produce the sounds required, and of much greater volume than in the first instance. Again, my theories had to give way to the cold fact that the only improvement I could produce on my subjects was a psychic one. Once more I laid my failure to lack of volume and returned to the telephone receiver, but this time, with the addition of an induction coil and auxiliary battery. I got volume now, but only again to meet with failure. Psychic results I had in plenty, but not physical ones, and it was real, tangible improvement I was after and I was reluctant to admit defeat of my carefully constructed theories, until I had exhausted every device my creative faculties could suggest. Even yet, I have not abandoned hope and still find myself devising new apparatus for this purpose.

Out of the failures, however, came one ray of hope, for I found, contrary to my belief, that more powerful sound waves were needed; the fact that when extraneous air currents are cut off and the external orifice of the ear occluded by a very sensitive diaphragm, a telephone receiver, giving a clear but subdued note, is capable of making an impression and that many of these patients are capable of hearing ordinary conversation through such an apparatus when virtually deaf, without such aid. This fact lends confirmation to my belief, that the loss of hearing in oto-sclerosis, and other degenerative processes, is due to a loss of elasticity of the soft parts of the conducting apparatus, either through atrophic or sclerotic changes, and impels me to continue the treatment of many a case that, otherwise, I would abandon as hopeless. In these cases, one cannot, as yet, expect much, but even a little means much towards mitigating the horrors of that continual silence, that is far harder to bear than the loss of sight. And these studies have taught me the greater lesson that the noises that prove so distressing are frequently due to outside influences, the various air currents striking on a drum head incapable of normal excursions are transformed into overtones or irregular tone waves that produce sound but not sense. So sensitive, in fact, may the conducting apparatus become, as the shrinking process stretches the drum head tighter, that when the ear is totally occluded by a non-resilient covering (sheet lead for example), bone conduction may still set in motion waves that will produce annoying sounds.

My greatest successes in the treatment of deafness, have been through the use of intestinal stimulants and the maintenance of thorough lymphatic drainage and the local use of iodine and potassium iodide, together with massage of the drum head by means of the pneumatic pump. In those cases of recent type, I have derived some apparent benefit from having the patient listen for some time each day to the same piece of music played by the phonograph, selecting something with which he was formerly familiar and giving close attention to the music. At first, only sufficient will be heard to recognize the meter, then fragments of the notes, and ultimately, more or less of the music will be heard. I hope some day that I or some one more able, will devise an apparatus that will automatically transpose music or spoken words into a higher or a lower key, for it is the voice register that is usually lost and there are still tone islands remaining for sounds above or below those of the normal eight octaves but the difficulties at present seem almost insurmountable.

An Aid In Deafness.—The Chief of the Swedish Government Telephone Bureau has made a miniature telephone, with an end piece suitable for insertion into the ear. Its size is four by six inches. Two such telephones placed in the ears and fine wires resting behind the ears could connect with a

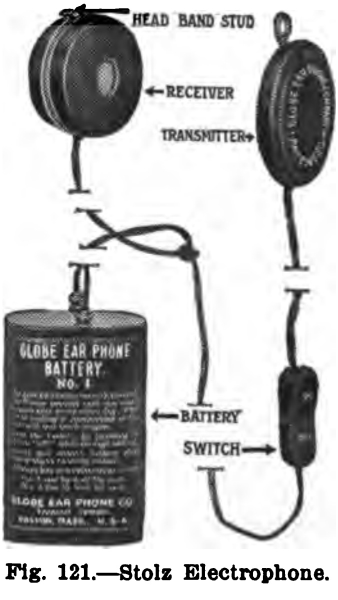


Fig. 121.—Stolz Electrophone.

battery and coil in the breast pocket. A microphone receiver in connection could be held in the hand. This would make a very efficient ear trumpet. Deaf people often hear well by telephone.

Fig. *121* shows transmitter connected directly with the battery.

CHAPTER II.

THE MASTOID.

Transillumination.—Dr. Albert H. Andrews, of Chicago, from a wide experience writes: Examination of the mastoid by transillumination is based upon the fact that the healthy, normal mastoid will transmit light, while a mastoid filled with pus or granulation tissue obstructs the passage of light. Most of the older authors claim the method is unreliable. The fault was in the lamp used.

The test is made by means of a small cylindrical twelve candle power incandescent lamp, covered with a soft rubber hood, having a *5/16*-inch aperture at the end for contact with the mastoid. The examination is conducted in a darkened room. A speculum is directed backward to expose the posterior wall of the auditory canal. The lamp is placed with the aperture against the back part of the mastoid and directed slightly forward. When the mastoid is normal, light can be seen in the auditory canal. When the mastoid is filled with pus or granulations, no light is perceptible in the canal. In more than fifty cases, in which light was not transmitted, pathological changes were demonstrated by operation.

The cases which have demonstrated the value of this method may be divided into: *1.* Acute cases, which, in the early stage, showed good trans-illuminations, but, as the case developed, light ceased to pass through the mastoid, while after the mastoiditis subsided, light was again transmitted. *2.* Acute cases which, transmitting light in the beginning, failed to transmit light as mastoiditis developed, and later operation showed the mastoid necrotic or the cells filled with pus and granulation tissue. 3. Chronic cases with obstruction to light transmission in which operation showed the presence of necrosis, pus or granulation tissue. 4. Intractable chronic cases with good illumination, in which operation showed open mastoid cells, with the cause of the suppuration in the antrum or attic. 5. Cases in which the lateral sinus was superficial and situated close to the auditory canal. In these cases, the sinus obstructed the light, but both above and below the sinus transillumination was good. In the examination of a number of negroes, little light was transmitted.

Because of the excessive heat it is a good plan to use the light by intermittent flashes.

Transillumination of the frontal sinus gives excellent results.

In the case of the maxillary antrum the light is so intense and is given off from so great an area, that shadows are not clearly defined, and the shadow of moderate opacities has been overlooked.

MASTOIDITIS TREATED BY PHOTOTHERAPY.

I will cite a few cases illustrative of the treatment of mastoiditis by phototherapy:

Mrs. J. C., aged 27, consulted me May 7, 1908. She had had suppurative otitis media and mastoiditis of the left ear for three weeks. The membrane has a small anterior perforation. Hearing distance = acoumeter at eight feet. The mastoid is red, tender and oedematous. She has had severe pain for forty-eight hours. Temperature = 102°.

℞. 500 c. p. lamp for one-half hour daily.

May 8, she has had no pain since the lamp was used on the previous day. Repeated the lamp treatment. May 9, temperature = 100°. No pain. Repeat lamp daily. May 11, temperature = 99°. June

6, no perforation in the membrane; no discharge. A low whisper is heard at twenty feet.

2. Miss D., aged *20*, had all the prominent symptoms of an acute mastoiditis during the week prior to consulting me in November, *1906*.

Treatment.—The mastoid was exposed, at twelve inches, to the *500* c. p. incandescent lamp for one-half hour daily for one week. All the symptoms improved each day, and at the end of the week had entirely disappeared, leaving the hearing normal.

There has been no recurrence to date. When the patient consulted me, the mastoid presented all the typical symptoms, that nearly all aurists consider an indication for immediate operation; with which opinion, I was in complete accord, before I had tried the effect of phototherapy.

3. Miss S., aged *15*, consulted me January *27*, *1908*. She has had mastoiditis of the left ear during the past week and purulent otitis media for a month. The mastoid was considerably swelled, very red and tender. I treated her by phototherapy, as in the previous case, with some slight improvement in symptoms, for two or three days; but, on February *1*, deciding there must be some caries of the mastoid present, I considered an operation was indicated. Upon making an exploratory incision, I found an extensive amount of caries present and performed a radical mastoid operation.

After-treatment with the *500* c. p. lamp was given for one-half hour daily.

March *19*, no discharge. Perforation of membrana tympani. Patient can hear a whisper at twenty feet.

Conclusion.—I have come to the conclusion that, in cases of acute mastoiditis, if caries is not present, the symptoms will yield promptly to treatment by the incandescent lamp. If they do not yield after a week or ten days' treatment, I conclude that caries exists and operate; from which, it follows that the earlier the patient comes under treatment the more likely it is that an operation can be avoided.

4. J. S., aged 20, consulted me July 11, 1905. The patient has had purulent otitis media of the left ear, since three years of age. There is a perforation at the lower margin of the membrana tympani. The discharge is now very free. Hearing distance = ½.

The right ear has discharged off and on since childhood, up to four years ago, and then ceased. There is a perforation which occupies the lower half of the membrana tympani; the hearing distance = ⅞.

Treatment.—From July 11 to October 1 local applications of tincture of iodine and 2% of silver nitrate were applied to the ears without checking the discharge. I performed the Schwartze-Stacke operation on the left ear. A moderate purulent discharge continued in spite of medical treatment for seven months after the operation.

The ear was then exposed to a 50 c. p. lamp, with a violet glass shade, at six inches, for fifteen minutes tri-weekly and after two treatments it was perfectly free of any trace of discharge. The treatment was continued, as a precaution, for a month. There had been no recurrence in ten months.

Herbert Pitcher, of Haverhill, Mass., reports a case of mastoiditis cured in five treatments by the 500 c. p. lamp.

The woman, aged 36, had been treated, he says, for a week before I saw her. There was severe pain around the ear, with tenderness over the mastoid. The membrana tympani was inflamed; temperature = 100.2°.

Application of strong light was made for fifteen minutes to the side of the head. She had a good night's rest, but some pain remained. The treatment was repeated, after which there was no more pain; and three more applications made the cure complete.

A. S. Roger, of Michigan University, reports the following:

Mrs. M., aged 42, had an operation for mastoid of left ear. Ten days after she was discharged from the hospital, the right mastoid became very painful and tender. Temperature = 102°. The 500 c. p. lamp was applied for fifteen minutes. The pain was entirely relieved. Three days later there had been no further trouble. The membrana tympani was normal.

X-RAY EXAMINATION OF THE MASTOID REGION AN AID TO DIAGNOSIS.

Samuel Iglauer, of Cincinnati, advises thus: Considering the difficulties frequently encountered in diagnosticating diseases of the mastoid process, it has for some time past seemed to me advisable to obtain radiograms of the mastoid region. In general, it may be stated that radiography should prove of great value in the determination of both the anatomic and pathologic conditions within the temporal bone.

THE USE OF THE BUR IN RADICAL MASTOID OPERATION.

Dr. William McEwen, of Glascow, says: The safest instrument for the purpose of exposing the antrum is the rotary bur propelled by a surgical engine, driven by hand or water power. The bur is held in the hand like a pen. A small bur is used on the child and a large one in a wide triangle. This instrument, applied lightly to the bone removes osseous flakes; leaving a smooth, almost polished surface, upon which any dark objects, such as are presented by the interstices of the mastoid antrum or any of the adjoining cells, are readily recognized previous to being opened. When one of these dark spaces is exposed in the bone, a searcher or probe ought to be introduced into it and the dimensions of the aperture determined. If the aperture communicates with the antrum, a small bur is applied to the margins until the whole of the external wall of the antrum is removed, the searcher being repeatedly used during the process to ascertain the antral dimensions and to follow its main irregularities.

CHOICE OF INSTRUMENTS FOR OPENING THE MASTOID ANTRUM.

Instead of using the bur throughout the operation Dr. McEwen says it may, at certain stages, be facilitated—especially if the bone be soft—by using a gouge for removing some of the superficial layers of the bone.

Objections to the use of the chisel and mallet.

First: Because in operating upon a restricted area, surrounded by and full of apertures, some containing delicate structures, the wounding of which may occasion serious and even fatal results, the antrum being situated at a variable depth from the surface, the intervening osseous tissue being of various consistency, it is a source of danger to use a chisel (driven by a mallet) which may be suddenly impelled into the interior of one of those spaces or into the cerebellum, brain or sigmoid—such accidents have occurred.

During attempts to open the mastoid antrum the sigmoid sinus has frequently been accidentally opened by the chisel, several of the cases surviving, though a number have died. In four unpublished cases, which have been communicated to the author, four surgeons, in their several endeavors to open the mastoid antrum, have accidentally driven the chisel into the sigmoid sinus. In each of these, there was profound hemorrhage, causing an abandonment of the operation, the parts being plugged to arrest bleeding. Three of these four ultimately died. In two of these the surgeons believed that death was due to the meningeal complications previously existing.

Secondly: The repeated blows with the hammer impart considerable vibration to the mastoid and adjoining structures, and, when the tegmen tympani or the sigmoid groove is eroded and thinned the concussion may cause these thin and friable structures to give way, or cause a rupture of the granulations covering them and thus permit inoculation of the fresh wounds in the membranes or in the brain itself. Pus within the brain or cerebellum, receiving through the skull a succession of violent vibrations or shocks, could easily be scattered; or a large abscess near the ventricles or meninges might, by the violent impacts conveyed to it, burst into the ventricles or meninges, thus producing serious if not fatal results.

One case was reported to the author, as follows: While the chisel and mallet were being vigorously applied to open a mastoid antrum, the patient's breathing was suddenly arrested; the relations of a large cerebellar abscess which was present being probably disturbed by the communicating vibrations. There was no laryngeal obstruction.

Thirdly: The aperture left by the chisel is rough and rugged compared with the polished surface and bevelled edges obtained with the bur, which greatly facilitate the after-dressing and treatment.

A Russian instrument for perforating bone is of service in boring an aperture through the bone into the antrum. It works easily and the bone debris which it pares off is gathered into the handle instead of being scattered about. Though not equal to the bur, it yet answers its purpose very well. The use of the trephine for opening the mastoid is, like that of the chisel, attended with danger, and is not advised.

Dr. H. R. Boettcher, of Chicago, has performed approximately *500* mastoid operations. From *1892* to *1905*, he used the chisel exclusively. He began the use of the bur in *1905*, and, for three years, he usually began the operation with the gouge and finished it with the bur. Since *1908*, he has used the bur exclusively for the whole operation. He considers the advantages of the bur are that the operation can be more quickly accomplished and with less concussion; that it is smoother and safer, as the approaching tissue can always be seen.—e. g. the bluish color of the lateral sinus. The proximity of the facial nerve is indicated by facial contraction caused by the stimulation of the nerve by the near friction of the bur, whereas the chisel may cut off the nerve without any warning.

Boettcher has never injured the facial nerve or the dura or opened the lateral sinus with the bur. The soft tissues of the sinus and dura not having a substratum .of firm tissue, yield to the pressure of the bur, unless too much pressure is used. Patients do not have the physical discomfort they feel the morning after a chisel operation. In the first few cases operated upon, slight superficial necrosis of the bone followed, as the bone was not kept moist to prevent over-heating. This can readily be prevented by an assistant dropping sterile water or salt solution, with a medicine dropper on the parts. In using the bur, too much force and too rapid cutting must be avoided.

It is not necessary to produce so profound an anesthesia as in the chisel operation, the patient being often awake or partially so during the operation. It is easier to follow the track of a fistula by gradually following up its course from the distal opening. The posterior wall of the meatus can be safely removed down to the triangular area. A foot switch should be used to turn the current on and off, rather than have an assistant control it.

Boettcher uses a Victor motor of *1/6* h. p. This company has made a round bur of four sizes after the MacEwen model. An olive-shaped bur is not practical.

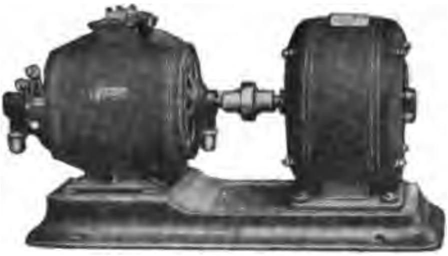


Fig. 122.—Electric Motor.

Dr. Frank Allport, of Chicago, says: For some time past, I have derived much satisfaction from the use of rotary burs driven by the Victor electric engine. This engine is simple, strong, easily controlled and always ready, and I find myself using the engine more and other instruments less. While I never expect to depend on the engine alone, I believe it to be a most useful addition to our armamentarium.

I cannot understand why the bur is not in quite general use, for, after many years of experience with it, I can frankly say that I consider it the best, quickest and safest instrument for cleaning out the interior of the bone. Of course, the operator must have a reliable and powerful motor, a strong and bendable cable (a second cable, with handle and a second foot 'cut-off,' should always be on hand in case of a break-down), a satisfactory handle and a proper assortment of burs capable of working in all sorts of cavities. I use a foot 'cut-off', so that when I press the knob with my foot the bur revolves, and when I take my foot off, it stops. I always work with an aseptic cloth sleeve drawn over the cable, so that I have no fear in handling it. The handle itself can be sterilized. In the motor which I use, the speed of the revolutions can be controlled by a handle. When using a bur, I do not attempt to hold the handle gracefully in one hand; the machine is too powerful for this, the bur would jump from place to place under such circumstances. We must have the bur under complete control in order to make it safe. I therefore hold this handle (down close to the bur) with both hands. My elbows are usually steadied against the head of the patient. If these precautions are observed the bur can be used with perfect safety, and it will not jump. I know of no instrument that can be used so efficiently and safely in delicate places, such as around an exposed dura, sinus, facial nerve, or horizontal semicircular canal; and as for smoothing off overhanging bone, cleaning out mastoid cells, 'rimming out' the eustachian tube, bevelling down the floor of the meatus, smoothing down the posterior wall of the meatus, cleaning out the aditus, and shaping up the cavity in general, and getting out all necrosed tissue, there is no instrument or group of instruments that can at all equal it. But I always say to a surgeon who intends using this instrument, not to be discouraged if he does not like it at all at first. He must know how to use it, and in order to do this he should not discard it until he has used it twenty or twenty-five times. After he has done this he will have become an enthusiastic advocate of the bur for mastoid work.

While using the bur, the cavity should be frequently washed out with warm sterile water, driven by a powerful syringe, as great masses of bone dust accumulate, and unless washed away would obstruct our view and impede progress.

The bur should be frequently cleaned by a nurse. as its teeth become filled with bone dust and do not cut well. The bone should be kept moist, either with blood, water or adrenalin, as otherwise the bone and the bur become over-heated and superficial bone necrosis may follow. I have had a number of these cases, where the first dressings were absolutely black and very foul smelling, but in these cases I have dressed the patients daily with powerful antiseptic douchings and powders, and in a few days this complication has passed away, and I have never seen any unfortunate consequences follow.

I take down all of the posterior meatal wall that I possibly can without injuring the facial nerve. The outer portion of the wall, perhaps the outer third, can be removed entirely and bevelled down so that it is on a level with the contiguous bone. As we progress inwards, however, we must remember that the facial nerve is contained within its structure and too much bone must not be removed.

As we bur into the meatal wall in this vicinity, on its edge we will occasionally see a little bleeding artery making itself manifest. This is the artery which accompanies the nerve, and when seen should be a signal to us to desist from further work in this vicinity.

The remnant of the meatal wall should be burred down with a fine bur, so that there are no rough places, nor elevations on it, and the floor of the meatus should be leveled down, so that there is no obstruction to good drainage. I think that almost all of these cases should be cleaned out way down to the tip cells, and every suspicious place. whether in the mastoid bone proper or in the zygomatic region, should be investigated by the bur and thoroughly cleaned out. When we are through operating, we should have produced a large cavity without any overhanging edges, and with every place in the bone looking smooth and healthy. The two hardest places to heal over, in my experience, have been the extreme innermost portions of the antrum, and the aditus ad antrum, but if these are thoroughly polished with suitable sized burs they will heal as rapidly as any other portion of the cavity.

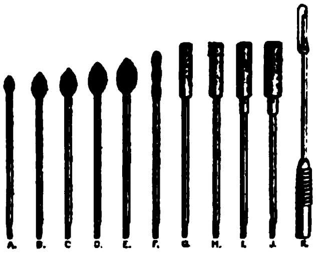


Fig. 123.—Burs, Drills and Trephines For Nasal Drilling.

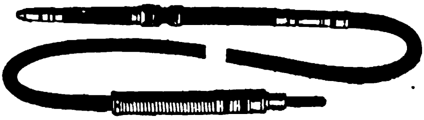


Fig. 124.—Surgical Cable For Burs, Drills, Etc.

CHAPTER III.

THE LABYRINTH.

THE DIAGNOSIS OF LABYRINTH DISEASE BY ELECTRICAL STIMULATION.

Nystagmus.—Rhythmic nystagmus of labyrinthine origin in response to certain stimulation is regarded as indicative of an intact and functional labyrinth and certain abnormal responses or failure of response to stimulation as indicating partial or complete disorganization of the labyrinth.

Rotation.—Normal responses; abnormal responses.

Caloric Nystagmus.

Hoege's Law.—Hoege demonstrated that when the muscle centre of one side is stimulated from the vestibular apparatus, the adductor ocular muscles on the same side and the abductor muscles on the opposite side contract, resulting in a slow conjugate movement of the eyes in a direction *away from* the stimulated centre. Thus, stimulation of the right centre brings about a slow movement to the left and vice versa.

Galvanic Tests.—In the rotation and caloric tests, nystagmus results from stimulation or inhibition of one of the centres by change of position of the ampullary cilia. In the galvanic tests, nystagmus results from altered electrical tension of one or other of the centres by conduction along the vestibular nerve. If one electrode be held in the hand and the other applied in front of the tragus, nystagmus and vertigo will be produced.

Living tissue, muscle, nerve centre, etc., is in a state of catelectrotonus, that is of increased excitability to an electric current at the cathode. In making the tests, the ordinary wall cabinet with milliampere meter and pole switch is employed. One electrode is held in the hand and the other is applied in front of the tragus.

The examiner must throw the light from his head mirror on the eye, raise the upper lid and be on the watch for the first signs of nystagmus. The current is turned on and gradually increased till nystagmus appears. The reading of the meter is noted as well as the direction of the nystagmus. Whichever pole is applied in front of the tragus, the nystagmus will always be to the cathode. Remembering that the centres are in a state of catelectrotonus, this is diagrammatically represented for both poles in the figures.

Before the current is turned on, both centres are equally balanced in a state of catelectrotonus. The cathode is now applied to the right ear. There follows a series of slow movements to the left, with rotary nystagmus to the right, or nystagmus to the cathode.

On the application of the anode to the right ear, the catelectrotonus of the right centre is diminished. The slow movement, therefore, is to the right and the nystagmus to the left—that is, it is as before, to the cathode.

In normal cases, nystagmus will be brought about upon the application of the cathode by an equal amount of current on each side and on the application of the anode by an equal amount on each side.

Six milliamperes is the average amount necessary to produce nystagmus when the cathode is applied, and eight or nine milliamperes the average amount when the anode is applied.

In the early period of a labyrinthine suppuration, galvanic reactions may be obtained even when the rotation and caloric reactions are negative. Later, however, degeneration of the vestibular nerve follows the destruction of its end organ, and, when this has occurred, the galvanic reactions will not be elicited.

With one labyrinth destroyed, the average milliamperage necessary to produce nystagmus is for the cathode ten and for the anode four. With one labyrinth hyperesthetic, the average milliamperage is for the cathode one and for the anode eleven or twelve.

The electrode which is applied in front of the tragus should be fitted with a make and break mechanism.

The following tables show the comparison of the cathodal and anodal opening and closing nystagmus:

*Normal nerve:—K. C. N. > K. O. N. 1 +
A. O. N. > A. C. N.

Vestibular
apparatus
destroyed:—K. O. N. > K. C. N. 2.
A. C. N. > A. O. N.

*K. = cathode. C. = closing. N. = nystagmus. A. = anode.
O. = opening. > = greater than

That is, the nystagmus is greater when the current is closed by applying the cathode than when opened by withdrawing the cathode, etc.

Figure 125 shows the effect of applying cathode to the right tragus (in diagram "right vestibular apparatus") when the labyrinth is normal.

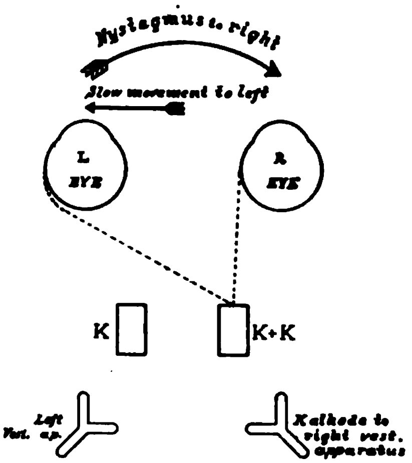


Fig. 125.

The K. K. opposite each other signify the electro-tonus is the same in each eye. The K. + is the applied cathode.

Figure 126 illustrates the effect of applying the anode to the right tragus.

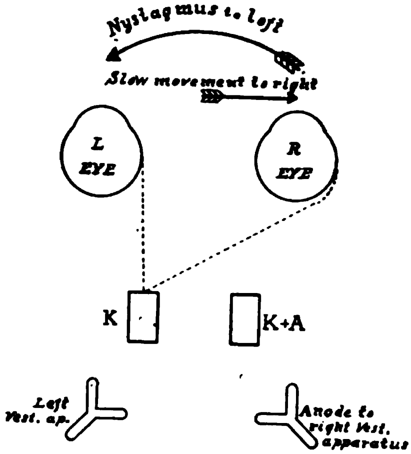


Fig. 126.

The above extract, condensed, with the diagrams, is taken from Wendell C. Phillips' treatise on "Diseases of the Ear, Nose and Throat."

LABYRINTH DISEASE.

In chronic, progressive deafness, due to spongification of the osseous wall of the labyrinth, no electrical treatment, of course, will be of any avail; but, in case of membraneous involvement of the labyrinth,—per se,—or as a complication of middle ear catarrh, there is much to be hoped for by the application of electricity.

I cite one of my cases, by way of illustration.

1. Dr. P. S., aged *39*, consulted me November *10*, *1905*. On July *20*, he retired at *2* a. m., after a long auto drive, and awoke the next morning unable to hear a street car or ordinary conversation. His hearing previously had been perfect. He, meanwhile, had consulted aurists, who had diagnosed his condition as otitis media and prescribed, with no result.

Present State.—Forced whisper is heard at three feet by right ear; bone conduction negative; air conduction poor. Rinné, R. and L. +. Humming tinnitus.

Diagnosis.—Effusion into labyrinth; possibly hemorrhagic.

Previous Treatment.—Potassium iodide; thiosinamin; sodium salicylate; sal. hepaticus, etc., for three months without result.

℞. Alternating current to moistened cotton, in meati, for fifteen minutes, daily.

The first treatment relieved the constant tinnitus for two hours. November *18*, R. or L. ear = forced whisper at nine feet. The hearing subsequently became normal, with further treatment.

Of fifteen cases of labyrinth disease, treated by the local application of static electricity, reported by Bayer, seven were improved or cured.

All catarrhal symptoms must be abolished before applying electricity. Bayer aims to flood the tympanum with the electric emanations, holding the electrode about one c.m. from the membrane. He prefers the brush for its soothing effect in congestion; and the spark when a stimulating action is desired. None of his patients were neurasthenic or hysteric.

CHAPTER IV.

GROWTHS IN THE EAR.

Angioma.—L. Egger reports a case of angioma of the external auditory canal, which he treated with galvanism.

The tumor, he says, was the size of a pea. The patient had suffered pain, while eating, for a month. The positive needle was inserted into the growth and a current of one to three m.a. was used. After six treatments, the tumor had almost disappeared.

In angioma of the auricle, electrolysis is perhaps the best method, the positive needle being used.

Ballenger, of Chicago, says that firmly embedded organic substances in the meatus may be treated by several applications of the galvano-cautery.

Law, of New York, successfully treated an epithelioma of the ear by the *x*-ray.

The patient was aged *70*, came to him August *20*, *1909*. The canal was only about the size of a pin; profuse discharge. It was exposed to the *x*-ray for ten minutes, tri-weekly, with a tube of moderate penetration.

November *12*, the patient has had twenty-five treatments. The canal is of normal size; there is no discharge, and the ulcer is healed.

Hennebert cites a case of cavernous angioma of the external auditory meatus, which he removed by the galvano-cautery snare. Erysipelas followed.

Foreign Body in the Meatus.—Voltolini advises the electro-cautery to diminish the bulk of certain bodies impacted in the meatus.

Part V.

Electricity in Diseases of the Nose.

CHAPTER I.

SOME NASAL AFFECTIONS.

ACNE OF THE NOSE TREATED WITH THE HIGH-FREQUENCY DISCHARGE.

Finley R. Cook, of New York, reports a case of acne rosacea of the nose, of an immense size, with marked nodulations, which had been under the care of several specialists and had received every treatment usually employed, including the x-ray, galvanic needle, and scarification.

Multiple discharges were made over the entire nose, during which process large cavities containing sebaceous material were opened and shrivelled, leaving a thick layer of necrossed tissue surrounded by an active area of hyperemia. Subsequently, the necrosed area dried, shrank, and assumed a blackish hue. Six days later, it began to loosen and was readily removed *en masse* without any sloughing. The underlying surface was in an active healthy condition of granulation, and new skin was already rapidly encroaching upon the denuded area.

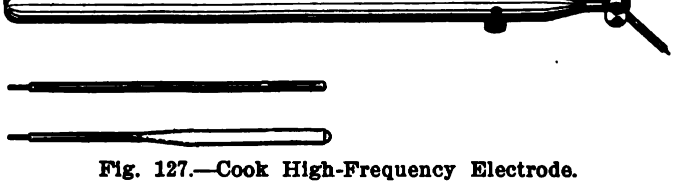


Fig. 127.—Cook High-Frequency Electrode.

Epidermatization was complete ten days later. It would seem that in these cases, the high-frequency metallic discharge is unique in its effects and probably the only reliable mode of treatment in severe cases.

Dr. Cook treated similarly a *mole*. It was seen first on September *5*, *1906*. After giving a two per cent hypodermic cocainization, the high-frequency discharge was applied till the entire growth was shriveled to the level of the skin.

October *10*, *1907*. A minute white spot only remains.

ACNE OF THE NOSE TREATED BY LIGHT THERAPY.

Julius Rosenburg, of New York, reports a case of acne rosacea of the right cheek and nose which he treated successfully with light.

—, aged *40*. Had had acne rosacea of right cheek and nose for four months. Seven treatments with the ultra-violet light removed every vestige of the disease, a few scars excepted.

He says: I used a *35*-amperes arc light, with mirror reflectors and iron-carbon electrodes.

He concludes: In acute and chronic neuritis, these rays will always relieve pain and in most cases, especially acute forms, will effect recovery. In acne and furunculosis, the curative effect is prompt and certain.

C. R. Dickson, of Toronto, Canada, uses under similar cases, a condenser spark lamp with iron electrodes, known as the "ultra." He reports the following case:

An acne rosacea, on the nose of a young woman, involving the greater part of the nose, was practically cured after twenty-nine sessions of five minutes each, to each side, extending over a period of three months.

TREATMENT OF SCAR TISSUE.

Thiosinamin has long been used internally, in doses of from one to two grains, in treating opacities of the cornea; but, lately, through the experiments of Hotz, Neiswanger and others, its use has become more extended.

It seems to have a selective action on scar tissue and is now employed, to a considerable extent, in the removal of scars and the treatment of strictures, enlarged glands and some middle ear lesions.

Hotz removed a scar from his own face by using a *10* per cent ointment of thiosinamin and lanolin.

Neiswanger employs it cataphorically in many cases. He reports complete relief in two cases of lachrymal stricture,

In removing scars for cosmetic or other purposes on the surface, his technic is as follows: A connector is attached to a piece of block tin, the size and shape of the scar to be treated. This tin is covered with absorbent cotton, which is then saturated with the following solution:

Thiosinomin	*20* grains
Glycerine	*2* drachms
Water	*6* drachms
Sod. Chlor.	*5* grains

Make a solution.

The electrode, as now prepared, is laid on the scar and attached to the anode of a constant current. The amount of current employed is governed by the active surface of the electrode and may be stated at from two to three to twenty or more m. a. for ten minutes.

In a day or two after each seance, a layer of epidermis will peel off, and a subsequent sitting should not be given until this takes place.

Dr. Neiswanger has treated a number of cases of Keloid successfully in this way.

NASAL HYDRORRHOEA.

Eugene S. Yonge says that, as local treatment in cases of nasal hydrorrhoea, the galvano-cautery has been recommended, but its use has been deprecated by a number of observers as being liable in some instances to aggravate the symptoms.

The necessity of refraining from any surgical procedure in a case of cerebro-spinal rhinorrhoea will be evident on account of the risk of intracranial infection. The removal of any nasal obstruction, in cases of nasal hydrorrhoea, would be advisable.

DILATED VEINS OF THE EXTERNAL NOSE AND SEPTUM.

Dr. Otto Freer, of Chicago, advocates the use of electrolysis for the destruction of dilated veins of the external nose and septum. He says, With positive galvanism, introduce a fine needle into each vein, using two to five m.a. of current, and taking a few seconds only for each puncture.

FROST BITTEN NOSES.

Helbing, of Germany, used galvanism, placing the anode and cathode upon opposite sides of the nose, and continually moving the electrodes. Strong currents should be avoided. Seances should be repeated tri-weekly. Twenty to thirty applications effect a cure.

REFLEX NEUROSES OF NASAL ORIGIN.

Julius Sommerbrodt, of Breslau, has treated *138* patients with the electro-cautery on account of reflex disturbances, only eight of whom had ascribed their affection to nasal origin.

The neuroses were as follows. (*1*) Vasomotor neuroses of the bronchial mucous membrane without asthma, *20* cases; *13* were cured, *1* improved. (*2*) Migraine, *14* cases; *8* cured, *1* improved. (*3*) Asthma, *52* cases; *18* cured, *12* improved, *5* not cured, *8* still under treatment, and *9* result unknown. (*4*) Reflex disturbances of the pharynx and larynx, *22* cases; *16* cured, *2* improved. (*5*) Attacks of sneezing; *6* cured. (*6*) Cough of nasal origin; all cured. (*7*) Neuralgia of the trigeminus, *3* cases; *2* cured. Instead of using the flat cautery for superficial application, he thoroughly destroys the affected erectile tissue with a spiral platinum cautery.

EPISTAXIS.

Miot recommends positive interstitial electrolysis in the treatment of epistaxis. He says that sixteen to twenty m.a. with a copper electrode should be applied to the bleeding part for ten minutes.

C. C. Rice, of New York, prefers electrolysis to the electro-cautery in the treatment of epistaxis. In three cases, resulting from septal erosions, he successfully employed metallic electrolysis.

Scheppegrell reports a case of violent arterial hemorrhage, following a septal operation, which he successfully and completely controlled by applying cocainized cotton to the bleeding point for five minutes and then applying a fine platinum electrode, heated to a bright red.

Calmette, of Paris, reports that in five cases he found success in the application of the electro-cautery.

PURULENT RHINITIS.

W. L. Jackson, of Boston, used eight m.a. with a copper positive electrode applied to the mucous membrane. A slow but positive cure followed.

Aerothermic Treatment in Nasal Affections. L. Lichtwitz, of Bordeaux, writing in *1901*, of the aerothermic treatment, draws the following conclusions as to when the method should be used:

1. In cases of spasmodic rhinitis.

2. In cases of acute and subacute rhinitis.

3. In cases of hypertrophic rhinitis, with obstruction.

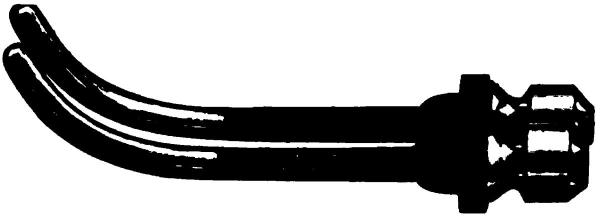


Fig. 128.—Sharp's Nasal Copper Bipolar Electrode for Cataphoresis.

OZENA.

Writing in *1906*, Tommaso Lucrezio states that he finds in literature the records of eleven cases of ozena that have been treated with currents of high-frequency.

Two of these he treated, with excellent results. The current is applied by the monopolar method, the electrode being covered with paraffin. A rational therapeutic plan will include the removal of all crusts, efficient antisepsis, and excitation of the regenerative functions of the tissues. The high-frequency sparks do all three of these things.

The sparks have electrolytic and antiseptic powers by which they produce effects on ferments, micro-organisms and products of secretion. The muscular fibres contract and, with the aid of the electro-static action, the exudate is removed. Ozone is produced which acts as a disinfectant. At the point of contact of the electrode, ischaemia is produced, followed by intense and lasting hyperaemia, leucocytosis and phagocytocis, so that the necrosed detritus is removed.

The method gives better results than any other, giving immediate relief and a rapid cure.

Dr. Clarence C. Rice, of New York, cites two cases of ozena which he treated with positive galvanism:

1. —, aged *15*, saw him November *27*, *1891*. Has ozena. The odor began four months ago. Mucopurulent discharge.

December *9*.—The patient has had four treatments with the direct current, a copper positive electrode having been applied to each nostril, with one m.a. for ten minutes. This treatment was continued tri-weekly until February *5*, when the patient is much better; less discharge, odor and headache.

Fig. 129.—Sharp's Single Copper Nasal Electrode.

2. —, aged *41*, came August *8*, *1893*, having ozena; post-nasal catarrh; copious, most offensive anterior and post-nasal discharge; crusts; nose bleeds freely.

Treatment.—Electric diffusion from copper bulbs to naso-pharynx, *15* to *25* m. a. for five minutes.

August 30.—The incrustations and discharge are much less; the sense of smell has returned for the first time in eight years; there is no odor. The patient expressed himself as fifty per cent better, and stated that no other treatment had ever accomplished so much for him. Unavoidably he discontinued treatment.

Taylor claims to have cured in a fortnight, with a nasal high-frequency electrode, a case of long standing.

Delevan, of New York, secured excellent results with galvanism. He used the negative electrode wrapped in absorbent cotton and applied directly to the nasal mucosa, with four to seven m. a. for seven to fifteen minutes. Watery secretion is thus induced.

As Scheppegrell points out, on account of its action on bacteria, the positive pole should be applied to the mucous membrane.

R. W. Seiss recommends faradism. He uses a straight positive nasal electrode, long enough to reach the pharyngeal wall. Cotton, dipped in an alkaline solution, is wrapped around the electrode. Seances of ten minutes are given.

Later Seiss states that he prefers massage as a routine practice.

Scheppegrell, writing in *1898*, says that the treatment which has given more permanent results than any other is cupric electrolysis.

McBride, of Edinburg, is also a strong advocate of this method—treating ozena with cupric electrolysis. He offers the following technic: The copper needle, attached to the positive cord, was inserted into the inferior or middle turbinal and, sometimes, into the tissues of the middle meatus, while the steel needle was passed into the septum, with a current of three to ten m. a. for ten minutes.

Four of the eight patients treated were practically cured of fetor and crusts. Eighteen months had brought no return.

Jouslain states that he has had most satisfactory results by the use of two cylinders, twelve centimeters long by six in diameter, of pure copper, which are inserted into the thoroughly cleansed nostrils. A current of five m. a. is used for five minutes; the current is then reversed and applied for five minutes more.

Copart has had remarkable results and believes that ninety per cent of all cases may be cured and that one sitting is usually sufficient.

He uses the bipolar method, with a current of twenty m. a. for twenty minutes; or, if the bipolar cannot be tolerated, he uses the positive monopolar method. In three hundred cases, he has never seen an accident from this treatment.

Bayer considers that in interstitial electrolysis, weak currents of six to eight m. a. should be used.

Goldstein, of New York, writes: In the treatment of the second class of cases, the tuberculous, with atrophic rhinitis, Dr. F. W. Law kindly followed my suggestion to apply the Oudin current with a nasal glass vacuum electrode for about three minutes in the nares. I must, however, confess that beyond the tonic effect of the current I did not notice any radical difference in the results from that which would have followed the use of oleo-sulphonate of soda, without any application of the current.

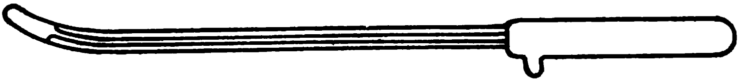


Fig. 130.—Vacuum Nasal Electrode.

However, in eight cases, I was surprised to find so much improvement in the naso-pharyngeal mucosa under this treatment, in those having tubercular lesions, as these cases have laryngeal and pulmonary involvement and are poorly nourished, etc.

NASAL MUCOSA.

Sensitive Areas. Prof. Killian finds that the sensitive areas of the nasal mucosa are usually as follows:

1. The anterior end of the inferior turbinate.
2. The front part of the septum.

3. The lateral wall of the nose, just above the anterior end of the middle turbinate.
4. The upper part of the septum about the tubercle.

Polypoid Degeneration of the Nasal Mucosa.—Draispul, of St. Petersburg, cites a case of polypoid degeneration of the nasal mucosa, in which one nostril was treated with the electric cautery and the other with electrolysis. Three weeks later, the former relapsed, while the latter appeared in a normal condition. He believes this effect may be attributed to the fact that electrolysis is more penetrating in its action than is the galvano-cautery.

ANOSMIA.

Leduc treated a case successfully by applying an intermittent galvanic current of three m.a., one electrode in the nose and the other on the bridge of the nose.

This was followed by faradism to each side of the nose for ten minutes.

CHAPTER II.

THE TURBINATES.

USE OF THE ELECTRO-CAUTERY IN THE NOSE.

My associate, Charles H. Long, in a personal communication says: The electro-cautery, used in operations upon hypertrophies of the soft tissues of the nose, when directed with skill, is a valuable asset to surgery. However, it must not be used indiscriminately, though it devolves largely upon the operator to determine when it is advisable. In doing this, he considers:

1. The nature of the hypertrophic condition; whether it is
  - a. Intumescent,
  - b. A true hypertrophy.

2. Its location in the nose.

3. Whether it is (a) a primary condition due to local nasal irritation or (b), a secondary condition due to
  - (x) Diseased tonsils,
  - (y) Systemic conditions (nephritis, sclerosis of the liver, etc),
  - (z) Certain reflex disturbances (asthma, hay-fever, etc.).

Appliances necessary for use of the electro-cautery:

1. Practical sources of current:

(a) Commercial current (direct, alternating). (b) Wet-lift battery.

2. Mechanical appliances:
   - (a) Rotary transformer, used with the direct current.
   - (b) Alternating current rectifier, with the alternating current.
   - (c) Wet-lift battery. (d) Cautery reostat.
   - (e) Cords, preferably of large size to reduce resistance to a minimum.
   - (f) Knives, consisting of end of cautery-wire formed into
     - x—Shapes, suited to the case:
       1. Flattened blades. 2. Shaped into points.
       3. Curved. 4. Angular.
     - y—Size, as small as possible and yet possessing the necessary rigidity.

The electro-cautery is used to the best advantage upon hyperplastic conditions of the middle and anterior portions of the inferior turbinal, the septum, and the tissues on the floor of the nose.

The use of the cautery upon the posterior end of the inferior turbinal and upon the middle and superior turbinals occasions dangerous reactions. In the first instance, the eustachian tube, being in such close proximity to the cauterized part, often carries infection to the middle ear; while, in the other cases, sinusitis and meningitis frequently follow.

The first step toward the removal of a hypertrophic condition, either primary or secondary, should be an effort to eliminate the contributive causes. When this attempt is successful, the hypertrophy often disappears, making the use of the cautery unnecessary. When, however, the hyperplasia fails to disappear, it may be successfully removed with the cautery. If it proves impossible to remove the direct or indirect causes, the cautery will often give temporary relief.

After a patient has reached the age of thirty-five or forty years, as a rule, and when atrophic conditions are present, the electric-cautery, or any cautery, is not advisable on account of the resulting destruction of the ciliated epithelium and the formation of cicatrical tissue causing: (*1*) the closing of ducts and blood-vessels, thus diminishing the normal supply of heat and moisture to the respired air, and (2) cystic degeneration. The function of the glands being thus destroyed, nasal obstruction speedily ensues, and, later, atrophy, due to progressive contraction of the connective tissue.

Technic.—There are two methods of applying the cautery: linearly, through the mucous membrane, and submucously. Operation may be performed after local anaesthesia has been secured; preferably by means of a *20* per cent cocaine hydrochlorate, applied by absorbent cotton pledgets, pressed as dry as possible from the solution, and allowed to remain upon the parts for ten to fifteen minutes. Care must be exercised that none of the cocaine solution finds its way to the throat.

After the application of the anaesthetic, the appliances should be tested. The proper working temperature of the cautery knife is a cherry-red heat, or a trifle greater. To secure this it may be necessary, after the knife enters the tissues, which have a cooling tendency, to slightly increase the current. The cautery wire is passed through the anterior nares to the rear of the part to be cauterized, with which it is then placed in contact. At this point the current is turned on and the knife is inserted with a saw-like motion until it reaches the bone, when it is drawn slowly forward. A cleaving of the tissues to the knife indicates a need of more current. One incision ordinarily suffices, and only in exceptional cases will more than one application be necessary. Relief is assured for at least two years, when it frequently becomes necessary to repeat the process.

The effect of the cautery is modified by the temperature of the knife-electrode, the size of the wire, and the duration of the application. Accurate technic will ensure successful operation without hemorrhage and with little danger of adhesions which are due to abrasion of the mucous membrane at the point opposite cauterization. Superficial burning causes the removal of an excessive amount of ciliated epithelium and incurs severe reaction.

Careful cleansing with a non-irritating alkaline lotion, applied by the patient as a nasal douche, or by the physician with a cotton applicator, must follow, but never in the form of sprays, as they often disturb the eschar and increase the danger of infection. Follow this by a mentholated oil, applied with an oil atomizer. The object of the after-treatment is to maintain free drainage and prevent adhesions.

Submucous cauterizations are performed with a narrow electrode, with which the soft tissues at the edge of the inferior turbinal are pierced in one or two places, the point being carried upward and backward under the mucous membrane to the distance of eight to twelve millimeters.

Accumulations of lymphoid or erectile tissue on either side of the bony or cartilaginous septum, causing nasal obstructions, especially those amenable to the contractile action of cocaine or suprarenal are successfully removed in a similar manner as the hypertrophies on the inferior turbinal, as are also the hyperplastic conditions on the floor of the nose. In these instances, however, more than one incision may be necessary to secure the required result.

Dr. E. Fletcher Ingals, in a personal communication, writes: In intumescent rhinitis and moderately severe hypertrophic rhinitis, nearly all of the obstruction arises from swelling of the inferior turbinated bodies. In such cases, the best treatment, as it appears to me, is by longitudinal cauterization of these bodies. In the mildest cases, a single cauterization through the middle of the body down to the bone so as to produce adhesions, will answer the purpose; but, usually, it requires two, one at the junction of the upper and middle third, the other at the junction of the middle and lower third. The cauterizations should be made about two weeks apart; first upon one side, then upon the other, and then back to the first again; so as to allow an inter-

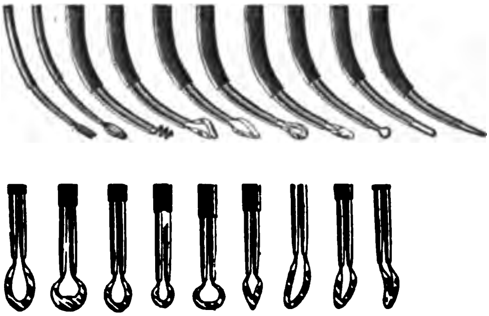


Fig. 131.—Nasal Cautery Knives.

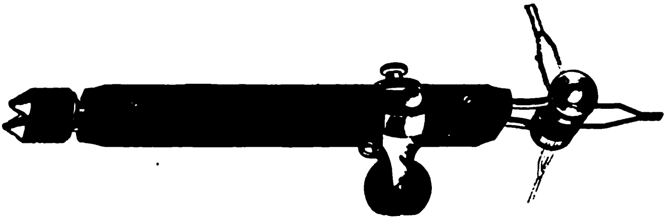


Fig. 132.—Adjustable Cautery Handle.

val of four weeks between the two cauterizations on each side.

I think the reason that many have failed with these cauterizations is that they use an electrode with too small a wire. If a platinum wire No. 22, or smaller is used, it has to be heated to a white heat or it will not burn through to the bone. In the first case, it will cause a good deal of bleeding and will not make a broad enough eschar; in the second place, only the superficial portions of the turbinated body are cauterized and only slight good will be accomplished. One should use an electrode made with a No. 20 platinum wire which should be heated to a cherry red heat, and should leave an eschar, when through, not less than one-twelfth of an inch in width.

Sometimes I make two lines together so as to make the eschar one-eighth of an inch in width. In the majority of cases of this kind, two cauterizations on each side will surely remove the difficulty, but, in a limited number, the relief may continue for only a few years; and possibly one or two more cauterizations will then be needed, and very rarely even three or four cauterizations upon each side will not answer the purpose; therefore, in cases where the two cauterizations upon each side do not relieve the obstruction completely, I dissect up the mucous membrane from the inferior turbinated on its inner side and cut it loose near the lower edge of the turbinated body. I then cut out about the lower half of the turbinated bone from which this membrane was removed and then press the flap down over the cut edge and pack the nose with gauze in a large finger cot.

This is left in for twenty-four hours, by which time all danger of bleeding has ceased and the gauze may be removed with the aid of a douche without causing pain. Where the hypertrophy is excessive, I still think it is desirable to make one or two cauterizations upon each inferior turbinated body, and then, if the relief is not complete, to resect the lower half of the inferior turbinated bones in the manner already suggested.

In a limited number of cases, the middle turbinated is also involved and then it should be reduced in a similar manner; but the cauterizations would have to be made more guardedly, and I usually perform them by simply thrusting a long broad point into the septal side of the turbinated body two or three times at each cauterization.

Cauterization of this body, however, is rarely needed; and, if it causes obstruction, it is better to reduce it by dissecting up the mucous membrane and cutting off a portion of the bone in a manner similar to that recommended for the inferior turbinate. In my hands, this form of cauterization has been very much better than any other.

It causes little or no pain and is very much less inconvenient to the patient than most other methods and one can count accurately upon the results.

Scheppegrell draws attention to the dividing line between rhinitis intumescent (Ingals) and true hypertrophy. In the latter only are surgical methods admissible.

Lenox Browne states that if the electro-cautery is used scientifically in hypertrophic rhinitis, it should effect the reduction of superficial layers of the mucosa by the formation of a slough and the shrinkage of the underlying vascular tissues by the formation of inflammatory adhesions to the periosteum.

For a large hypertrophied inferior turbinated body, he plunges a long and slender cautery point into the cavernous tissues in a direction close to, and as near as possible parallel with the inferior border of the bone. In moderate cases, one or two such procedures may suffice; but, when the condition is very marked and little reducible, he prefers the linear superficial cauterization also, especially along the inner and lower sides of the turbinated body.

T. A. de Blois states that there are two extremes: The first, in which the cauterizations are not made sufficiently, and in which the parts soon return to the original hypertrophic condition; and the second, in which it is overdone and the nostril is left full of cicatrices. Ingals applies a cautery with a flat guard to prevent it coming in contact with the septum.

Scheppegrell says that in general the cautery should be heated to a cherry red. If the circuit is opened before the cautery is lifted from the tissues, the eschar may be torn away and bleeding occur. If the wire is too hot, bleeding also takes place.

Otis H. Maclay, writing in *1909*, says that opinions vary as to the use of the galvano-cautery in the nose, from an absolute opposition to an equally enthusiastic endorsement.

Depending upon the method employed, we speak of a *submucous* or a *puncture* cautery and a *linear*. Either may be superficial or deep, but the puncture cautery is deep, since it consists of plunging the heated electrode into the body of the tissue, where it remains for a moment and is then removed while still hot; the object being to gain reduction of the tissue with a minimum loss of mucous membrane. The reaction has been too decided with us and the improvement not sufficient to warrant its preference over the linear.

By the linear method, we burn a line, superficial or deep, along the entire length of the enlargement at its greatest bulging. The direction varies from the horizontal on the inferior turbinate to an almost vertical cautery on some soft bulging of the septum. This should always be accomplished with a narrow edged electrode, which should not be allowed to slide laterally; for broad destruction of the epithelium would be followed by slow healing and crust formation.

The part is anesthetized with ten per cent cocain solutions for five minutes; then, the No. *21* platinum wire is introduced, while cold, heated to a dull white heat, placed against the tissue and gently drawn forward with a to and fro motion. The wire is then, while still heated, withdrawn. Deep cauterization may reach the bone or cartilage. The burning may be repeated on the opposite side in a week or longer. Forcible removal of the slough, causing bleeding, must be avoided. The best results are obtained in intumescent rhinitis, but we find it beneficial up to, but not including, the hyperplastic type, in which the removal of the tissue is best. Where the turbinate is very broad, we can resect the lower portion and later cauterize the remainder, which we believe to be better than the complete removal.

Charles Knight says that the electro-cautery, judiciously used, is one of the most valuable agents at our command.

Seth Bishop, of Chicago, emphasizes that not more than one-third of the turbinate should be treated at a single cauterization. In order to avoid tearing away the burned parts, and thus causing bleeding, the cautery must be removed while still hot.

Ingals and Friedburg, writing in *1907*, state the following conclusions:

1. In cases uncomplicated with deviations or exotosis of the septum, the galvano-cautery, properly applied, is the method of treatment *par excellence.*

2. In cases complicated with deviations or exostosis of a moderate degree, the cauterization of the turbinal bodies will be sufficient to bring about complete relief without the necessity of performing operations on the septum.

3. The dangers of middle ear infection have been greatly exaggerated. Only one case, among several thousand cauterizations, having come under our observation.

4. The liability to adhesive formation is not great, provided the opposite septal mucosa is not injured, and, provided that, when the swelling is marked, a probe be passed between the opposing surfaces on the fourth or fifth day.

5. The objection that the galvano-cautery destroys too much mucous membrane is not valid, if the cauterization is linear and done properly.

6. Scab and crust formation does not occur oftener than after other nasal operations.

7. No packing is necessary to prevent hemorrhage.

8. There is very little, if any pain after the cauterization.

Norval H. Pierce, of Chicago, has always been conservative in the use of the electro-cautery.

Pynchon, of Chicago, uses it only in well marked cases, but, when required, applies it vigorously.

J. L. Goodale, of Boston, writing, in *1904*, of the ultimate results of cauterizing the lower turbinate, offers the following conclusions:

1. Caustic applications to the nasal mucous membrane may cause a loss of the columnar ciliated epithelium, with a replacement of this by squamous cells.

2. Such applications may cause an obliteration of the canaliculi in the basement membrane.

3. Immediately below the cauterized mucous membrane new connective tissue may be formed, which extends downwards to a depth dependent upon the intensity of the trauma.

4. The contraction of the tissues is due to this new-formed connective tissue.

5. Repeated superficial cauterizations tend to the formation of connective tissue immediately beneath the epithelium, which, by its contraction may constrict the lumen of the ducts of the glands, and lead to cystic dilatation of the latter. This may contribute to a subsequent return of the nasal obstruction.

When the mucous membrane is relaxed, it is best contracted by deep narrow linear applications of chromic acid or of the galvano-cautery, or by submucous cauterization.

On the other hand, in order to diminish the amount of nasal fluid, broad superficial applications to the septum and lower turbinals, posteriorly, should be used. If the enlargement recurs, it is best to excise it.

As a means of lessening the reaction after the use of the galvano-current, J. W. Gleitsman suggests applying immediately to the wound a thick coating of dry trichloracetic acid. In eighty cases, in which he had made this application after using the cautery, there were sixty-two which experienced no unpleasant after-effects; only in eighteen was reaction felt. The eschar was eliminated in from twenty-four hours to seven days. Subsequent treatment was confined to cleansing of the nose and insufflation of aristol.

Complications after using the galvano-cautery:

The application of the electro-cautery to the nose has been followed by meningitis (Wagner); sinus thrombosis (Lange); exophthalmos (Semon); pseudo-membraneous inflammation of the faucial tonsils (Scheppegrell); synechia, between the septum and turbinal (S.); severe hemoptysis (W. C. Phillips); acute otitis media (C. H. Burnett); purulent mastoiditis (Ferreri); epistaxis, and disturbances of vision (Scheppegrell).

HYPERTROPHY OF THE TURBINATE.

Dr. Homer M. Thomas, of Chicago, in a personal communication writes: I am, and for twenty years have been opposed to the use of the galvano-cautery in the nose as a cure for nasal hypertrophies. I have observed so many ill results upon the nasal membrane (Schneiderian) that it is never used in my practice. I consider a clean cutting operation much more scientific, and that the reaction is much less severe and the healing process more rapid.

Ballenger, of Chicago, writing in *1911*, says: In cases of hypertrophic rhinitis, if the hypertrophy is great enough to obstruct the nasal passages it should be removed surgically with scissors, saw or spokeshave.

He adds: The actual cautery has been recommended for the reduction of hypertrophied mucous membrane. I can only condemn it as inadequate for the purpose. If it is used freely enough to accomplish anything, it produces excessive scar tissue, a result to be carefully avoided.

Ballenger reduces soft hypertrophies of the septum by means of the electro-cautery. He says these hypertrophies occur at the anterior portion, just opposite to or below the inferior margin of the middle turbinated body, and at the posterior end of the former. In the first instance, the enlargement interferes with the proper ventilation of the superior meatus and the sinuses draining into it.

Technic: First, apply a five to ten per cent solution of cocaine to the parts with a thin pledget of cotton. Make one or two linear incisions through the hypertrophied tissue with the actual cautery at a bright cherry red heat.

This may be repeated two weeks later, if the first application was insufficient to reduce the mass. In posterior hypertrophy, the same procedure may be followed, the operator having first reduced the engorgement of the turbinated bodies with a spray of one to one thousand solution of adrenalin.

THE PASSING OF THE GALVANO-CAUTERY IN THE TREATMENT OF DISEASES OF THE NOSE.

Willis S. Anderson, of Detroit, writes: Any measure which is followed by scar tissue in place of healthy mucous membrane leads, later, to a train of disagreeable symptoms, which may be nearly or quite as annoying as the original affection. The formation of crusts or scabs over the site cauterized often causes constant annoyance for months or for a lifetime.

While admitting its place in nasal disease, I believe it has been used too extensively and that we have more satisfactory measures. Nine per cent of normal middle turbinates contain one or more cells. If these cells are infected at the time of cauterization, septic symptoms may develop and even lead to a fatal meningitis. Packard writes that he has found several deaths reported from meningitis, which followed the use of the cautery in the nose.

In selected cases, good results follow the cautery in hypertrophy of the inferior turbinate, but at a sacrifice of mucous membrane and with the result that dried mucus accumulates over the cicatrice. If the septum is touched, adhesions often result.

The Trephine.—G. Melville Black, of Denver, advises the use of a nasal trephine, two and a half inches long.

The trephine, operated by an electric motor, is placed against the anterior and inferior portion of the turbinal and a semi-circular or circular piece is removed from the entire length of the body. If the hypertrophy is confined to a portion of the turbinate, the trephine is limited to that portion.

The only objection he finds in this method is the rather free hemorrhage. He claims for this method:

1. The clean-cut surfaces fall together and heal by first intention, thereby, at once, restoring free nasal respiration.

2. There is but little secretion, after twenty-four hours.

3. There is no perceptible cicatrix.

4. Rarely is more than one operation required.

5. There is no danger of adhesion of the turbinate to the septum.

He states that the method cannot be used with the middle turbinate.

ELECTROLYSIS IN THE TREATMENT OF HYPERTROPIC RHINITIS.

In hypertrophy of the inferior turbinate, I prefer electrolysis with the bipolar needle to all other methods of treatment. It is the least painful; is never followed by infection, meningitis and death; by hemorrhage or any nasal discharge. Crusts never form to give temporary or permanent annoyance. In short, electrolysis is the method *par excellence.*

I cite two illustrative cases:

1. E. C., aged *17*, consulted me July *11, 1902.* Present state—he is obliged to use his handkerchief constantly, on account of a nasal discharge. The throat gets so clogged that he can hardly talk. His hearing is sometimes imperfect and he snores in his sleep. A ridge extends from the middle of the left side of the septum to the posterior border and is in contact with the hypertrophied inferior turbinate.

Adenoids are present; and there is hypertrophy of the right inferior and middle turbinals.

I performed an operation as follows: The septal ridge, one and one-quarter inches long, was removed with the trephine, driven by the electric motor; and the left inferior turbinate was cauterized. The adenoids were curetted with a steel finger-nail.

September.—A bipolar needle was inserted into the right inferior turbinate.

October *2*.—Repeat the bipolar needle, with twenty m. a. for fifteen minutes.

October *21*.—Bipolar needle, with *20* m. a. for fifteen minutes, in right middle turbinate.

December *4*.—The left nostril is free, and very slight discharge continues.

Bipolar needle is inserted in left inferior turbinate. Recovery is complete.

2. Miss J. B. S., aged *20*, consulted me March *9*, *1904*. She has so profuse chronic nasal catarrh that she is obliged to use three or four handkerchiefs before leaving home in the morning. The hypertrophy of both lower turbinates is so large as to leave very narrow meatuses. The right turbinate is in contact with a septal ridge.

℞. Electrolysis, with a current of fifteen to twenty m. a. applied to a double needle, inserted into each inferior turbinate for five minutes.

March *19*, *1904*.—The patient now uses only one handkerchief a day. The left side is free; the right is still too narrow. Repeat the needling, with ten to twenty m. a. of current,—of the right inferior turbinate.

May *8*, *1912*. Has had no nasal trouble since the last operation. There is good nasal space.

Scheppegrell writes: "In using electrolysis, the object is to reduce the hyperplasia and break up the network of dilated blood vessels, as with the electro-cautery; but to effect this by means of a submucous operation."

An experience of several years with electrolysis has convinced me that in those cases in which it can be carried out, especially by the bipolar method, the results are more satisfactory and more lasting than from any other procedure.

A current of thirty-five volts will answer the requirements. The Edison current of *110* volts may be used.

With a view of obviating the objections of the mono-polar method, I commenced, in *1885*, to apply the bipolar. While, with the monopolar method, a case required fifteen to twenty minutes, with the bipolar it requires only two to five minutes—and without pain. Ten m. a. can frequently be borne and two to five minutes is usually all the time required.

An experience of over one hundred cases enables me to deduce the following points as compared with other methods:

1. It is a more conservative operation, as it effects the reduction of the tissues without destroying the mucous membrane.

2. It is not more painful and but little more difficult to the skilled operator. It has no after pain.

3. The reaction is very slight, as the electrolyzed tissues are frequently absorbed instead of sloughing off as in other methods.

4. The probabilities of a relapse are much less than in other methods. I have never yet seen a synechia form.

The cases in which the method is not practicable are: (*1*) In children or very nervous cases; as the operation is not performed as rapidly as by means of the electro-cautery; (*2*) in some nostrils it is difficult to insert the needles, and in these cases some other method must be adopted."

Flatau, of Berlin, uses the bipolar method and states that a current of forty m. a. should not be exceeded, and that the time should be limited to four or five minutes. He has not seen any untoward results follow these applications.

J. R. Briggs, of Texas, advocates the use of electrolysis for the destruction of hypertrophies of the turbinals and adenoid vegetations. He passes a cathode needle into the tissues to be dstroyed. In some cases, he applies to the surface of the adenoids a nasal electrode and claims this has been successful in cases in which other methods had failed.

Clarence C. Rice, of New York, has used metallic electrolysis in hypersecretion of the mucosa; in the irritative cough due to pharyngeal and laryngeal catarrh. In hypertrophy of the turbinates, he introduces a copper needle into the tissues, with five to ten m. a.. In twenty cases, six were cured; while seventy-five per cent were decidedly improved.

Rice cites the following case of hypertrophic nasal catarrh: —, aged *34*. For three years the patient had "dropping in the back of the throat," dullness in the head around the eyes; has used a handkerchief constantly; good deal of nausea.

April *28*.—Electrolytic diffusion, positive pole, three m. a. for fifteen minutes to left nostril.

June *24*.—Has had seventeen treatments of five m. a. for ten minutes to nose and pharynx.

Went for a vacation.

September.—Returned. Cured.

Albert H. Andrews, of Chicago, writes thus of submucous electrolysis of the inferior turbinal:

In a number of cases it has seemed desirable to bring about a great amount of shrinkage in the soft tissues with the least possible reaction; especially in the simple chronic cases, by submucous electrolysis.

The only special instruments required are two sharp needles (steel as well as any) four or five inches long, and an ordinary cautery handle. The needles should be insulated with shellac, in their middle portion, where they are liable to come in contact with the anterior nares. The needles should usually be inserted three-quarters of an inch to an inch, till the shellac enters the soft tissue. If the two needles are of the same length, and one is entered in advance of the other, when the point of the second comes in contact with the tissue where the first entered, the distance the second extends out of the nostril farther than the first is the distance the first has penetrated the turbinal. The second needle may now be introduced parallel with the first and four to six m. m. from it.

Care must be taken that both needles are still deep in the turbinate and have not passed through. The cautery handle is now attached to the needles, and eight to ten m. a. of current, for eight to ten minutes are usually sufficient. The turbinals will show a rapid blanching near the needles. In withdrawing the needles, hemorrhage may be avoided by attaching the negative wire to the positive needle and the positive wire to an electrode held in the hand; then, turn on two m. a. till the needle comes out without traction: or, loosen the handle from the needles, turn it over, reattach it, and turn on the current till the needles move readily.

The tissues which have been destroyed are rapidly absorbed and the connective tissue formed contracts and binds the mucous membrane to the bone. Also, destruction of the blood vessels interferes with the blood supply and shrinkage occurs. The procedure can be repeated in a few days.

The advantages of this plan are:

1. The slight reaction, in proportion to the results obtained.

2. The freedom from danger of secondary infection from dust or from discharge within the nose.

3. Absence of pain or discomfort either during or after the operation.

VOLTAIC TURBINAL PUNCTURE FOR THE RELIEF OF INTUMESCENT AND HYPERTROPHIC RHINITIS.

T. E. Neris, of Denver, writing in *1907*, cites ten cases successfully treated by this method:

Case *1.* October *8*, *1906.* Mrs. —. A typical case of anemic turgescence of both inferior turbinates, which were lying on the floor of both nasal chambers. This was my first case and I was not familiar with the technic. A positive copper needle was used to puncture the turbinal and three m. a. were applied for one minute. This needle adhered and the poles were reversed for a minute, which loosened the needle. The next day, the stenosis had increased. I then inserted a negative gold needle into the inferior turbinate. The gold negative needle was used once more in both inferior turbinates to a depth of two inches. Thereafter, the turgescence was sufficiently shrunken and the exudation had completely subsided.

With the negative pole, any metal could be used without oxidation; and steel, being stronger, is preferable to gold.

Voltaic is here synonymous with galvanic, and is preferable to it; as, to Volta properly belongs the credit of devising the first battery.

Snaring.—P. Watson Williams says that the galvano-cautery snare has the advantage over the cold snare, that it cuts through the tissue more rapidly on posterior hypertrophy of the inferior turbinate, and it more readily seizes hold of the turbinate without slipping.

CHAPTER III.

THE NASAL SEPTUM.

ELECTROLYSIS FOR THE REDUCTION OF THE NASAL SEPTUM

W. E. Casselberry, of Chicago, says: I wish to disclaim any idea of endorsing electrolysis as a universal substitute for the surgical method. The surgical method, in the case of bony spurs, is certainly more effective than is electrolysis. Certain European operators have advocated the method. My own experiments have been undertaken to determine in what class of cases it is possible to avoid a sanguinary operation and to reduce spurs of minor degree, which are scarcely deserving of surgical treatment.

Moritz Schmidt, in his book, *1894*, confirms the efficacy of the method as advanced by the French operators. Ballenger, of Chicago, in *1894*, reports three cases:

I have adapted the Edison electric light circuit to the purpose by means of a lamp resistance and a McIntosh current controller. The current strength necessary is from fifteen to forty m. a. I have used exclusively the bipolar method; as it is conceded by all to be equally, if not more, effective than the monopolar and it is more convenient to the operator and less disagreeable to the patient.

Not more than two needles, one representing the positive and the other the negative pole, should be employed. The part of the needles intended for insertion into the spur should be from fifteen to twenty m. a. in length; one-half of a m. m. thick; and three m. m. distant from each other. Irido-platinum is the best material for the needles. They are most convenient when soldered to metallic conductors running through a light handle. I have treated ten cases which may be classed in three types.

Type *1*. Cartilaginous Spurs.

Case *1*. Mr. R. An excrescence from the quadrangular cartilage five to six m. m. thick almost occluding the right nostril. The needles were inserted one above the other, well toward the bottom of the spur and extending almost through, a distance of eighteen m. m. A ten per cent cocaine solution had been previously applied, on cotton, to both sides of the septum for fifteen minutes. The current was gradually increased to forty m. a. and maintained for eight minutes, during the last five of which the patient complained of feeling faint. The spur had assumed a mottled blue and whitish aspect.

At the end of two weeks, the slough had disappeared, with pronounced loss of substance. Had it been more so, perforation must have resulted. At the end of three weeks, the treatment was repeated for five minutes, leaving abundance of space and a fairly even surface.

To avoid a perforation, the electrolytic action should be discontinued on the slightest mottling in hue or escape of gas from the opposite side of the septum.

Case *2*. Three treatments, at intervals of three weeks, with ten to twenty-five m. a. for six minutes. Result satisfactory.

Type *2*. Mixed Cartilaginous and bony spurs.

Case *6*. Mr. H., aged *25*. March *1*.—Twenty to twenty-five m. a. used for seven minutes. March *19*.

—Repeat. April *30*.—Spur much reduced. Result fairly satisfactory.

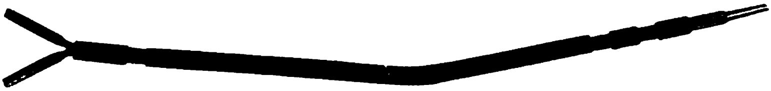


Fig. 133.—Casselberry's Bipolar Needles.

Type *3*. Bony Spurs.

Mr. R., aged *19*. March *20*.—*20* m. a. were applied for four minutes, when the patient nearly fainted and treatment was discontinued. The needles would not penetrate thoroughly into the spur.

April *27*.—The spur is unchanged. Electrolysis again attempted. This also failed, for the needles could not be made to penetrate; and the patient nearly fainted after three minutes of ten m. a.

In case *10*, electrolysis was abandoned and the surgical method substituted.

Conclusions. — *1*. Strictly cartilaginous spurs can be thoroughly removed by electrolysis; one, two or at most three operations being required.

2. The amount of reduction by electrolysis is commensurate with the proportion of cartilage of which they are composed.

3. Spurs, composed wholly or largely of hard bone, cannot be successfully treated by electrolysis.

4. Electrolysis is powerless to correct deviated septa of any form.

Ballenger, of Chicago, presents two cases which he treated with electrolysis, one of deviation, the other a bony spur.

1. —, aged *28*. There is marked deviation of the septum to the right side. A single, negative needle was introduced into the bony accretion along the line of the crescent, with eighteen m. a. for twenty minutes. One week later, the treatment was repeated, with complete success.

Case *2.* —, aged *25.* There was a bony ridge of the septum, one inch long, causing serious stenosis. The needle was introduced the entire length of the ridge, and the current applied as in the previous case. The patient became faint in ten minutes. He was placed reclining and the current continued for fifteen minutes, a total of twenty-five.

One month later, the septum showed slight evidence of the existence of the ridge.

No sloughing or other ill effects followed the treatment in either of the cases.

H. Holbrook Curtis, of New York, claims the following advantages in septal operations, by the nasal trephine run by a motor: *1.* Greater rapidity than by any other method. *2.* The tissues in the neighborhood of the deviations are not torn; a clean opening is made and there is no annoying hemorrhage. *3.* If the position of the posterior plate of the deflected septum is not visible, an exploratory canal may be made. *4.* The shock is less than in using the saw. The bone may be removed with less force and greater accuracy than with any other method.

Scheppegrell says that the trephine has now its most useful field in operations on the antrum of Highmore and mastoid cells.

Bergonié and Moure insist upon the bipolar method, on account of the liability of the perforation of the septum, due to the dispersion of the current, when the monopolar method is used. The concentration of the current within the growth by the bipolar method, avoids the destructive action of dispersion and prevents the pain felt in the monopolar method.

Meyer advises a current limited to fifteen to twenty m. a. for five to ten minutes in bipolar electrolysis.

Althaus has shown that not even bone can resist the electrolytic effect of negative galvanism.

Scheppegrell remarks that while a current of twenty m. a. may be used with impunity in a large chondromatous thickening, provided the needles are not brought too near the septum, the same current would develop a perforation in a less prominent cartilage, unless the application be made of very short duration. A much stronger current is tolerated in the bipolar than in the monopolar method.

Where the latter must be used, the dispersing electrode should be applied to the face or neck, as near as possible to the active electrode to prevent subjective symptoms.

Seth Bishop, of Chicago, says, that in removing long and large spurs from the nasal septum it is necessary to trephine through the center of the spur; then above and below the center in lines parallel with the first section, if the small trephine is used.

Regarding the use of electrolysis for the relief of certain morbid conditions of the nasal septum, J. E. Newcomb, of New York, writes:

Seiler states that in those septal enlargements, big enough to be regarded as ecchondroses, ossification has, in most instances, taken place.

In this special application of electricity, Miot, is the pioneer. Others had used it upon hypertrophied turbinate tissue, but he was the first to employ it upon the nasal septum. He employed both the monopolar and bipolar methods. One cord leads to the needle in the nostril, while the other is attached to a broad electrode on some indifferent area on the body. He reported ten cases, all cured. Garel employs a slender needle, *3—4* c. m. long, inserted into a copper tube united with the negative wire. The needle is covered for a variable distance with rubber, so as not to burn the skin, and is inserted *2—3* m. m. deep in the region of the nasal projection. At first, he used a single point, but later employed a small three-tined fork, the tips being near together. The positive pole he placed upon the upper area. His seances lasted fifteen minutes, and a dosage of *10* to *16* m. a. was registered. Two or three seances were necessary to remove the offending mass. There were no disagreeable after-effects except an occasional headache. After some days, the sphacelus was detached, leaving a sort of gutter-shaped cavity upon the salient point of the obstruction. Garel has reported thirty cases thus treated; twenty-six men and four women, ages varying from five to sixty-two years. Twenty-one cases presented a true localized thickening from the normal plane of the cartilage, and, in the remaining nine, the projection was associated with an adjacent depression. In two cases, perforation of the septum resulted from the action of the current, but with no evil consequences. In six, the operation was undertaken to obtain sufficient room for the subsequent removal of polyps. In one case, there was slight faintness at the commencement.

Peyrissac reports a case treated by the monopolar method. A hospital interne, aged *26*: The right nostril was almost completely occluded by a septal spur, which impinged upon the inferior turbinated bone. The positive pole (a steel needle) was inserted into the spur and the negative flat electrode placed upon the nucha. Intranasal insertion caused a momentary sharp pain in the incisor teeth. The current was quickly run up to forty m. a. and the entire seance lasted twenty-five minutes. A *10* per cent cocaine solution was freely applied. The disagreeable subjective features were incisor pains, visual disorders, lachrymation, a sense of smoke in the room, etc. The needle was inserted for a distance of 12 m. m. The intensity of forty m. a. was continued for four or five minutes, and held at twenty m. a. for fifteen minutes. Slight pain in the nose continued for eight days, by which time the sphacelus had come away. A complete relief of all symptoms resulted.

Moure and Bergonié, in "La Traitement des Déviations," etc., Paris, 1892, review the work of their predecessors and express their hearty approval thereof. They answer objections made by various rhinologists and append a wealth of clinical experience. They discuss the general question under three headings:

1. Which of the two methods is preferable, the monopolar or the bipolar?

2. In either case, ought the electrolyzing points to be arranged singly or in series?

3. In the monopolar method, which pole should be inserted in the offending mass, and where should the indifferent electrode be placed?

They answer these inquiries, in brief, as follows:

1. There are certain thickenings which can almost be regarded as pedunculated. Under these circumstances, the monopolar method is preferable, but under all others, the bipolar should be selected.

2. A single point only should be used at each pole. Moure and Bergonié claim that since they have followed this course, their patients have felt less pain, no perforations of the septum have occurred, and, except in very rare instances, the desired result has been attained at a single sitting. Whenever single points are used in either method, the lines of flux are concentrated upon tissue to be removed and not diffused over the surrounding normal area. Also, pains, salivation, phosphenes, etc., are avoided.

3. These observers find, practically, no difference between the destructive effects at the two

poles. Garel prefers the negative pole. The phenomena of reaction are less marked and the absorption of the necrosed mass is more rapid. Furthermore, G. Weiss (*1890*), finds no difference between the destructive results at the two poles. Moure and Bergonié find, however, that the detachment from the tissue of the positive pole very rarely causes a hemorrhage, while that of the negative is very often accompanied by a slight flow of blood.

Meyer reported before the Berlin Laryngological Society (Dec., *1892*), a series of cases treated by the bipolar method. He used a submucous injection of cocaine for the local anaesthesia. In some instances, he carried the current up to *30* m. a. Care should be taken to wait until the old eschar falls off before any renewal of the treatment is made. He believes that a neglect of this causes perforation of the septum, two instances of which occurred in his own cases.

In the discussion, Meyer's optimistic views were confirmed by Rosenberg, but opposed by Flatau. He had tried the method and abandoned it. He regarded it as painful and had observed after it violent hemorrhages. Moreover, he believed it destroyed only cartilage and not bony tissue.

Newcomb says the bipolar method is, doubtless, the preferable one. The steel needles supplied for sail-makers are, from their size, finish, and fineness of point, in every way preferable (diam. *0.5* to *1.5* m. m.; length, *7* to *10* c. m.). Steel needles are preferable to those of gold or irido-platinum (Bergonié), because they penetrate the tissue more easily. No objection attaches to the action of the current upon the steel, because the salts formed thereby are salts of iron, not harmful and possibly haemostatic. If curved needles are desired, the steel can be easily softened in the flame of a spirit lamp and bent as desired. The attached ends are covered with a fine rubber tubing. The depth of insertion varies with the amount of tissue to be removed. The average duration of each seance should not exceed fifteen minutes, and the dosage should not exceed thirty m. a., frequently fifteen are enough. The current should be carefully raised to the maximum and as carefully lowered to zero. It is impossible to estimate the amount of space gained till several weeks have elapsed after the operation. A galvano-cautery tip can be used to trim down any small excresences which may remain. The existence of pregnancy or the menstrual epoch contra-indicates operation.

Does this method of treatment offer any advantages over other methods, and what are the limits of its application?

1. First in its favor, is the fact that it is bloodless.
2. The field of operation can therefore be kept in view.
3. There is no after-inflammatory reaction.
4. There is practically no possibility of after-intranasal adhesion or deformity.
5. It is claimed that it is painless.
6. It is a possible alternative in certain cases of marked thickening, associated with deviation of the septum, where an operation for straightening the latter is deemed unlikely to prove successful.
7. Electrolysis will frequently be allowed by nervous patients who would refuse a cutting operation of any kind.
8. The laity attach much importance to the workings of electricity upon the human body.

Newcomb cites the histories of two of his personal cases:

J. B., German, watchman, aged 61. Patient's previous health had always been good, except that he has been quite deaf for the past two years. Physical examination showed some post-nasal catarrh. The right inferior turbinate was enlarged and the cartilage of the septum was somewhat deviated to the left. The left inferior turbinate was enlarged posteriorly; marked obstruction to air current on the left side. The septum was cocainized *10* per cent for eight minutes, and the needles (a bundle) were inserted at about the middle of the ridge. (No. *5* needles *1* m. m. by *5* c. m.) Twenty cells registered *15* m. a. and the current was continued for six to seven minutes. The needles wre inserted *1* c. m. The patient complained of quite a little pain at the site of the operation. Four days later the offending mass had lost one-third of its bulk. The treatment was repeated as above. At the third visit, the mass had still decreased, but a small round perforation was noticed.

Case *2*. B. W., aged *22*, has had occasional cough for the past seven years. For three months she has had nasal stoppage on the left side, with frontal headache and a sensation as of a foreign body in the back part of the left nostril. The cartilage of the septum deviated to the left posteriorly with a blunt spur on its left anterior inferior aspect projecting nearly half an inch from the septum. Electrolysis was applied as in case *1*, nine m. a. for five minutes. There was very slight pain in the nose. Two days later, the spur seemed reduced nearly one-half. Electrolysis was again applied, but *2* to *3* m. a. caused considerable pain. Five days later, there was a third sitting, *10* m. a. for five minutes. The spur was still further reduced.

Oct. *23*, the patient was cocainized for *15* minutes. The contact of the needles caused intense pain, requiring a discontinuance of the sitting.

Oct. *27*, tried *10* m. a. with more pain resulting than at last sitting, and again, on Nov. *3*, so that the last two sittings had no effect on the eventual result.

The patient was again seen on Dec. 7, when it was found that the spur had entirely disappeared. There was some nasal dryness, but all intranasal symptoms had disappeared.

The writer believes that the use of the trephine would have brought about the same results far more quickly. On the other hand, after making all due allowance for Gallic optimism, the statements of the Continental workers cannot be lightly thrust aside. Electrolysis deserves a further trial.

CHAPTER IV.

NASAL GROWTHS.

Electro-Cautery in Nasal Growths.—Bosworth, of New York, prefers the use of a caustic, such as chromic acid, to the cautery in nasal growths and various diseases of the nose.

Ingals, of Chicago, thinks that chromic acid is more painful than the electro-cautery; produces a more slowly healing sore and its effects, he considers are more uncertain.

My own experience agrees with that of Ingals.

Scheppegrell concurs with the opinion expressed by Bosworth that the use of the electro-cautery in nasal surgery has been over-estimated, or too extensively used; but says that this need not prevent us from appreciating the true value of the instrument, and in cases where it is indicated, it is incomparably superior to all chemical cauteries that may be used for the same purpose. He adds: In the application of the electro-cautery in tumors, and especially in tumors of a malignant character, the repeated cauterization of a small area cannot but have a deleterious effect on account of the reaction which is set up and repeated. The same rule applies here as in electrolysis, and the best results have been obtained with the latter where a powerful destructive effect has been produced in one or two sittings, whereas repeated sittings, with mild currents would have aggravated the symptoms. He gives the following caution: In general, the cautery should be heated to a cherry red. If the circuit is opened before the cautery is lifted from the tissues, the eschar may be torn away and bleeding occur. If, on the other hand, the wire is too hot, bleeding may also take place.

NON-MALIGNANT TUMORS OF THE NOSE AND THROAT.

Scheppegrell says that nasal polypi are more effectively treated by the cold snare; and, as the tendency of myxomatous growths to hemorrhage is slight, the simple method of the cold snare is the more practicable.

Lefferts, New York, states that the cold snare should always be given the preference. Where the polypi are very small, the electro-cautery may be used to advantage, and it is also indicated for destroying the tissues which form the base of the neoplasms. In nasal tumors which cannot be treated by the snare on account of their formation,—very sessile—or on account of their disposition to bleed (angiomata), the electro-cautery may frequently be applied to advantage.

Varicose Tumor.—Gongora, of Barcelona, reports a case of varicose tumor of the posterior inferior septum, which had given rise to repeated epistaxis during a period of three years. The growth was destroyed by the electro-cautery, without recurrence.

Simple Myxomata. — Scheppegrell now uses cupric electrolysis and the results from this method have given him more satisfaction than from other forms of treatment.

Sajous advises a zinc or silver needle, connected with the positive pole; the negative electrode being placed on the nose. With this polarity, the metal is acted upon and dispersed into the growth.

Angioma of the Nose. — Strazza of Genes, treated successfully by electrolysis a large cavernous tumor of the septum, in which a previous attempt to remove it with the snare had been followed by violent hemorrhage.

Post-Nasal Fibroid. — Kaarsburg, of Copenhagen, applied, with the bipolar method, one hundred to three hundred and twenty m. a. to postnasal fibroids, and obtained rapid and permanent good results.

The galvanic current not only produces chemical decomposition of the fluids and solids of the body, the disintegration of the electrode, and the transference of these substances through the tissues, but also produces trophic changes in the tissues.

Lipoma of the Nose.—R. W. St. Clair reports the following case of lipoma of the nose:

Mr. C., aged 54, came to me with a large tumor on the end and left side of his nose. It had nearly closed the nostrils, so it was with the greatest difficulty he could eat or drink, as he must get his breath through his mouth.

To remove it by excision was to encounter severe hemorrhage. The positive sponge was placed on the right side of the neck. The negative pole was armed with three needles, each with its own cord, so that one or more could be used as desired. I gave the growth eight cells for six minutes, with all three needles pushed through the tumor, and he did not even wince. The next seance was five days later, when I used six cells and two needles for five minutes. This was repeated every five days for three weeks. I destroyed all the tumor. The mass was firmly adherent to the cartilages of the nose, but with care I did not injure them at all.

It is best to go slow, use as few cells as will do the work and with short sittings.

Rhino-Scleroma Treated With the X-ray.—M. J. Ballin, of New York, cites the following case:

—, aged *63*, a Russian; duration of the disease, sixteen years. The uvula had disappeared; the nasal passages were entirely occluded.

Tri-weekly exposures to the *x*-ray, for three to four minutes, during five months reduced the nose to almost its normal size.

Cervical Enlargements.—M. O. Terry, of Utica, New York, reports the following case as an instance of the resolving effect of the medicated galvanic current on a growth:

Young woman, with twenty-eight cervical enlargements on the neck. After three months of treatment, only three small enlargements remained.

The positive pole was placed posteriorly and the negative on either side or over the enlargement.

To a pint of warm water, add half a drachm of tincture of iodine and an ounce of Am. Mur; into which dip the sponge electrodes—rather 'I would advise the negative sponge electrode only. Use a current of twenty to forty m. a. (or produce a comfortable warmth) for ten to fifteen minutes, and repeat the treatment every five days, until there is marked improvement, then every seven or fourteen days for several months.

Angiomata of Nose and Mouth.—Kaarsburg, of Copenhagen, treated eight cases successfully by electrolysis. He passed a current of fifteen m. a. for five minutes through the growths and recovery occurred in a few weeks.

Papillomata of the Nose and Larynx.—Aysaguer, of Paris, removes these with the cautery snare and subsequent cauterizations.

Naso-Pharyngeal Tumors. R. Lincoln, of Detriot, considers the electro-cautery snare superior to all other methods in naso-pharyngeal tumors.

J. E. Logan, of Kansas City, reports a case of tumor of the naso-pharynx destroyed by the electro-cautery without recurrence, though it had been previously removed eight or nine times. The patient died three years later with sarcoma of the stomach.

Scheppegrell cites a case of naso-pharyngeal tumor, in which the tumor had been constricted so slowly with the cold snare, to prevent hemorrhage, that it required twenty-four hours to remove it,—with the most agonizing pain to the patient. The tumor recurred and was removed by the electro-caustic snare in a few minutes, under cocaine, with little pain.

Scheppegrell considers that the advantages of electrolysis over the surgical methods in the destruction of tumors are: (*1*) The avoidance of hemorrhage, (*2*) the absence of suppuration when the rules of asepsis are well observed, (*3*) less danger of recurrence, and (4) the small degree of pain if the current is properly applied.

Except in special cases, there should be an interval of a week between each sitting.

R. P. Lincoln reports a successful case of fibroid tumor of the naso-pharynx, which had been twice removed surgically, but had recurred. He inserted two needles, attached to the negative pole, and connected the positive pole with two large dispersing electrodes. After sixteen treatments, at intervals of four to six days, each seance lasting twelve to twenty minutes, the patient recovered. Treatment was attended with a little pain and some dizziness. As Scheppegrell remarks. this could have been avoided by the use of the bipolar method.

Voltolini refers to a case of meningitis following electrolysis of a tumor, which he attributes to the badly constructed needles. With the improved instruments of today, there is little danger of complications. He believes that naso-pharyngeal tumors can be radically treated by electrolysis.

Strong Currents.—Kuttner found that seventy to eighty m.a. could be used in treating fibromata without injury to the patient and with the effect of decreasing the time necessary for treatment.

Kaarsburg is the most pronounced advocate of strong currents, which he employs with marked success. He cites the following case:

Young man, of eighteen years. A fibroid tumor had been removed by means of a snare and resection of the nose without success. The tumor now again filled the naso-pharyngeal cavity. Under chloroform, both electrodes were passed into the tumor, a current of three hundred m. a. being passed for eleven minutes; and, afterwards, with needles of a different length, three hundred m.a. were passed for fifteen minutes. The tumor was partly gangrenous and was removed by tracheotomy, forceps and scissors. No recurrence in three years.

PORT WINE MARKS TREATED WITH HIGH-FREQUENCY.

Bergonié advises the use of the secondary winding of a high potential transformer; and, for electrode, a metallic rod enclosed in a glass tube. A sheet of ebonite, with holes of various sizes to limit the sparking.

The skin grows white in a minute. An area of one to two sq. c.m. is sufficient to treat at one sitting. The healing should be complete in eight days and it is not necessary to apply any dressing.

EPITHELIOMA OF THE NOSE TREATED WITH THE *500* C. P. LAMP.

Rogers cites two cases, successfully treated by light:

1. —, aged *79.* Thirteen years previously an eruption appeared upon the right side of the nose and slowly increased in spite of treatment, till, eight years ago, when he came under the care of a leading dermatologist of Chicago. During three years, it was curetted, etc. For the succeeding five years, the doctor applied the *x*-rays twice weekly. Still it increased and a surgical operation was advised. I saw the case, in consultation with Dr. Tyler. After using the *500* c. p. lamp for six months the deformity was slight and the scar tissue inconspicuous.

2. —, aged *41*, had been treated unsuccessfully for three years by two prominent dermatologists. On October *24*, *1908*, the *500* c. p. lamp was applied for two minutes.

November *20*, *1908*. The crust came off, leaving a perfectly smooth surface. The light rays were applied several times during the healing to limit the formation of scar tissue.

Rogers says: "Destroy deeply and destroy beyond the diseased area."

LUPUS VULGARIS.

Lupus vulgaris appears most commonly upon the nose. If the diseased surface is extensive, with considerable infiltration and small ulcerative patches, Rogers says to apply the *500* c. p. lamp daily for fifteen minutes, without cauterizing or blistering. If any of the ulcerative patches are of considerable size or appear indolent, they should be cauterized. If the scaly patches are small, they may be quickly cured by superficial cauterization.

LUPUS TREATED WITH HIGH-FREQUENCY SPARKS.

Pensier recommends that, in the treatment of common lupus of the skin and mucosa, high-frequency sparks should be applied for ten to twenty seconds. The following day the skin peels off and a superficial ulcer results. With each sitting the inflammation spreads, but the suppuration is moderate. The cicatrix is pale and attached to the adjacent tissue. This procedure unites the power of mechanical and thermal effects and electrolysis. The destruction of the nodule produces, in twenty-five seconds, a superficial ulceration. Beautiful cosmetic effects are also obtained in erythematous lupus.

PRIMARY LUPUS VULGARIS OF THE ORO-PHARYNX AND NASO-PHARYNX TREATED BY X-RAYS.

Birkett, of Montreal, reports the following case of a boy, aged fifteen, who came under his care, November, *1902*. Local treatment, curetting and lactic acid in glycerine were used without any result. In April he commenced to treat him with the *x*-ray. The patient opened his mouth and held the screen close to his face so as to let the *x*-rays pass through the hole in the screen and strike on the back of the throat. At the end of July, after twenty-three treatments, the lupus condition had completely disappeared.

Four months later, a slight relapse occurred, when the *x*-ray treatment was renewed with satisfactory results.

ANGIOMA OF THE NOSE.

The galvano-cautery loop is adapted to the removal of these growths, when easily accessible and pedunculated, as it prevents hemorrhage.

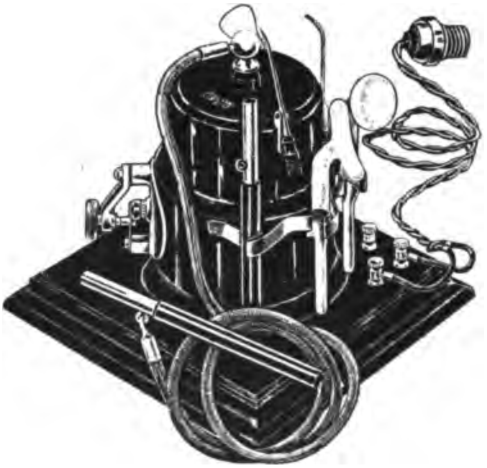
ANGIO-SARCOMA OF THE SEPTUM.

Draispul reports a case of angio-sarcoma of the septum, which had been twice removed and recurred in three months. He removed it with a snare and treated the base with electrolysis. Recovery followed, without recurrence.

A COMPARISON OF TREATMENT OF SKIN DISEASES.

Ballenger, speaking of lupus of the nose, says: "This may be treated by x-ray, Finsen light, the leucodescent lamp (*500* c. p.), or radium."

C. W. Allen, of New York, basing his opinion on seven hundred cases, states that he believes radiotherapy to be superior to Finsen light for the great majority of skin affections. The great value of the high-frequency currents lies in the sparking in such a way as to destroy new growths and cutaneous lesions. He finds that lupus erythematosis, etc., may be eradicated in one sitting.



134.—Portable High-Frequency Generator.

CHAPTER V.

HIGH-FREQUENCY HIGH POTENTIAL CURRENTS IN DISEASES OF THE NOSE AND THROAT.

Isaac C. Soule, of Kansas City, writes a suggestive technic for the application of high-frequency currents in various diseases of the nose and throat, as he has found them practically successful in his own experience:

Acute Rhinitis.—Spray with zymoline and follow with ten per cent cocaine and adrenalin, if the parts are very sensitive.

The author's flat low-vacuum electrode, under inspection, is advanced along the lower turbinate, avoiding the septum. Increase the current gradually and continue for six minutes. Spray with warm alboline. Apply the electrode over and on the sides of the nose for six minutes more. Repeat the next day and until the mucous membrane is restored to normal.

Chronic Rhinitis.—Cleanse the nose, then use a flat high-vacuum electrode. Increase the current to a warm sensation, applying for six minutes, then follow with a one-eighth inch ball high-vacuum electrode, giving fine sparks, using a to and fro motion over the infected surface, for three minutes. Finish with a warm oil spray.

Atrophic Rhinitis.—Remove all crusts possible. Anesthetize slightly. Use the author's platinum point ball electrode with high-vacuum. Sparks one-sixteenth to one-eighth inch over the remaining crusts will soon loosen them, so that they can be easily removed. Spark the entire cavity, particularly about the openings of the accessory sinuses, until it appears a good pink, generally in three minutes.

Take the one-quarter inch ball electrode and go over the mucous membrane with a vigorous rubbing motion for two to three minutes more with a current giving a gentle spark. Spray with bland oil. Repeat daily; and, when especially bad, pack the nose with lamb's wool, and use small surface high vacuum electrode with sufficient current to produce warmth over the outside of the nose and cheek.

When the mucous glands have not been destroyed, improvement is rapid. In incurable cases, this method has given more, and more lasting relief than any other.

Acute Tonsilitis.—Cleanse the tonsil and empty the crypts. Use the author's fused-in platinum point vacuum tonsil electrode, with sparks of one-eighth to one-quarter inch, over the surface for two to three minutes. Two or more attempts will have to be made at the sparking, as most patients will be unable to control the gagging. Apply the electrode in contact and turn on the current; then, soon, withdraw it a short distance. Spark one place but a few seconds, or the tissue will be destroyed. Use a glass or wooden tongue depressor. Use a low vacuum electrode to external surface for seven to eight minutes.

When seen in the early stages, a few treatments, repeated at times within six hours, if very greatly inflamed, or within twenty-four hours at most, will control the vast majority of cases in twenty-four or forty-eight hours.

If there is danger of abscess formation, use the author's bipolar small surface electrode, with as strong a current as is comfortable. Avoid getting too much heat or the surface will be blistered.

Several cases, which, seemingly, were determined to suppurate, have been aborted by the use of this electrode.

Following this treatment, acutely infected tonsils become smaller than before infection.

Acute Laryngitis.—Cleanse the larynx. Use the author's curved laryngeal or throat electrode. Place the electrode in position and increase the current gradually until some static sparking occurs, and continue for seven to ten minutes. Have the patient inhale alcohol at night if the cough is troublesome. Two treatments, at least, should be given before the voice is used.

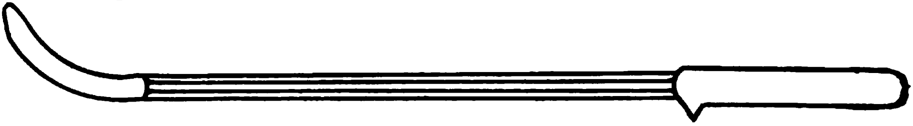


Fig. 135.—A Nose and Throat High-Frequency Vacuum Electrode.

CHAPTER VI.

THE ACCESSORY SINUSES.

RADIOGRAPHY AND TRANSILLUMINATION IN DIAGNOSIS OF SINUS DISEASES.

Dr. Joseph C. Beck, of Chicago, says that so far as the application of radiography to nasal diseases is concerned, he must admit it is much neglected. A number of rhinologists, he says, have been disappointed with their results. This is due to imperfect technic. He considers that the best remedy is for the rhinologist to assist the radiologist in obtaining the best results.

He offers the following general deductions:

1. That the real value of a skiagraph for diagnosis of sinus disease is in taking an antero-posterior exposure.

2. That the skiagraphs taken in the transverse are of but little value for diagnostic purposes, owing to the fact that one side is superimposed upon the other, but it will give an outline of the sphenoidal as well as the anterior group of cells as to their shape and size.

3. A transverse line across the orbit is found if the angle at which the plate is taken is correct, and this line is found about half an inch below the supraorbital margin.

Diagnosis by the X-ray.—Langworthy says: "So much information is given by the *x*-ray plates, that hardly any sinus operation should be performed without them. To clinch the diagnosis of pus in the ethmoids or frontal sinus, the use of the *x*-ray should be resorted to, taking a picture of the face, antero-posterior view. Lateral views are not of as great value, although they do give the height and size of the sinus and its encroachment on the brow; while transillumination cannot be relied upon to give this information.

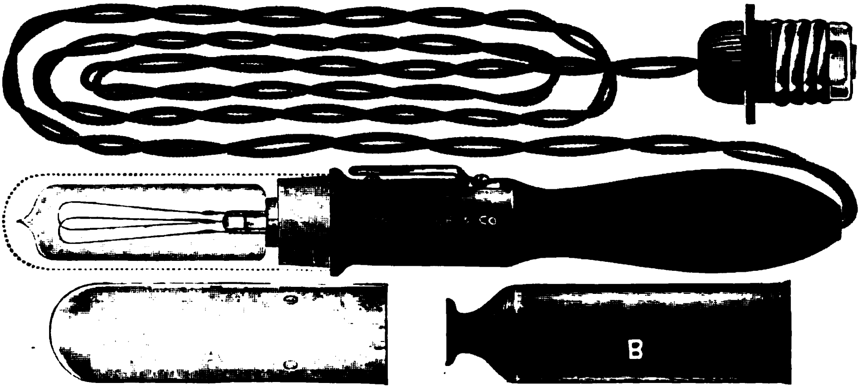


Fig. 136.—Transilluminator, for Use on the 110 Volt Direct or Alternating Current.

Seth Bishop, of Chicago, says that in operating upon the maxillary antrum, the large trephine gives better results than the other. The large trephine he considers, is well adapted for opening the frontal sinus and the mastoid antrum.

Scheppegrell says that the trephine, operated by the electric motor is much used to perforate the antrum, through a tooth socket; the canine fossa, or inferior meatus.

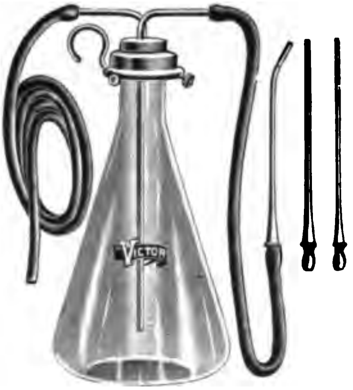


Fig. 137.—Harkin's Suction Bottle to Work on Suction Pump.

TREATMENT OF THE SUPPURATIVE DISEASES OF THE ACCESSORY SINUSES AND OF THE NOSE AND EAR BY MEANS OF OZONE.

Scheppegrell writes: The most economical and practical method of generating ozone for this purpose is the ozonizer described by Siemens. A sort of Leyden jar is prepared by coating the inner surface of a long glass tube with tinfoil, and passing over this a second wider tube, also coated with tinfoil on its outer surface. Between the two tubes, a current of oxygen is passed, which becomes electrified by induction; the inner and outer coating of tinfoil being respectively connected with the terminals of a strong induction coil. By this means, it is possible to convert ten to fifteen per cent of oxygen, passed through the ozonizer into ozone.

Pure ozone is a powerful oxidizing agent. It possesses strong bleaching and disinfecting properties, and attacks cork, rubber and the organic substances. The simplest test for ozone is to moisten a piece of blotting paper with a solution of potassium iodide; and the exposure to the ozone liberates the iodine, which shows its characteristic brown color. Ozone is a rapidly oxidizing agent, and, in sufficient degree of concentration, is very irritating to the mucous membrane of the respiratory passages.

I decided to prepare the ozone directly from the oxygen found in the atmosphere. This could be used directly, as it was prepared in the required degree of dilution. I found the nitrogen products were so infinitesimal that they could be neglected.

In some cases, it is desirable to heat the ozone to the temperature of the body by passing it through a bent tube inserted into a bowl of hot water. Only a mild current of air should be passed into the ozonizer. I have found it more practicable to diminish the proportion of ozone by regulating the induction coil, than by increasing the amount of air.

In applying ozone to the nose, care should be taken that the patient does not inhale it. This may be avoided by allowing the vapor to pass only during expiration, the cut-off being closed during inspiration. The application need not be made for more than ten to twenty minutes; and repeated not oftener than two or three times a week.

Where the method has been carried out correctly, no bad effects were ever complained of. The local effects of this treatment are not only good, but frequently striking.

In a case of antral disease, in which the discharge had been profuse and purulent, after the second application, the discharge almost lost its purulent character, and diminished very much. After fourteen treatments, during ten weeks, the case appeared cured, and the artificial opening was allowed to close.

In a case of maxillary sinusitis, combined with empyema of the frontal sinus, which had been treated by oxygen without success, a similar change in the quantity and character of the secretion took place, and the treatment resulted in a cure.

In five cases of chronic suppurative otitis media, which had been treated by this method, in three the suppuration ceased entirely, in the fourth, there is an occasional discharge, while the fifth is under treatment. I have also used ozone in five cases of ozena and the results thus far have been encouraging.

Part VI.

Electricity in Diseases of the Throat.

CHAPTER I.

THE TONSILS.

Hypertrophied Tonsils Treated With High-Frequency Metallic Discharge.—Finley R. Cook, of New York, writes: This current has been found exceedingly useful in the reduction of morbid and hypertrophied tonsils. Its application is practically painless, causes the tonsil to shrink and undergo rapid degenerative changes, and is followed, in from three to five days, by complete exfoliation. In the case of soft and moderately enlarged tonsils, complete reduction is accomplished at one sitting. In aggravated cases, it is preferable to divide the operation into a number of sittings. It is especially adapted to adults, where more or less danger from hemorrhage attends the operative procedure. I believe, by some modification of technique that adenoids could be treated with equal success.''

Dr. Cook cites the following cases of hypertrophied tonsils treated by high-frequency metallic discharge:

Miss —, aged *55*, came February *7*, *1907*, had suffered as long as should could remember with tonsilitis during the winter. For the past two years she had had a cough and expectoration; lost twenty pounds in weight, had chills and fever and night sweats. Both tonsils were moderately swollen and flabby and multiple crypts were filled with cheesy deposits.

She had chronic catarrhal pharyngitis. Moderate high-frequency discharges were made over both tonsils and were not painful. At the end of a week the tonsils had markedly shrunk, no morbid crypts were in evidence; the cough, chills and fever and expectoration had subsided. The general health was greatly improved and the patient gained five pounds in weight. Another slight treatment was given.

October 15, there had been continued improvement in health, with a gain of twelve pounds in weight. No tonsillar trouble since her first treatment, although a cold had caused a mild laryngitis.

HYPERTROPHIED TONSILS TREATED WITH THE ELECTRO-CAUTERY.

Charles A. Parker says the cautery point is plunged into the tonsil and the hole enlarged. Two or three cone-shaped holes may be made at one sitting and the opposite tonsil may be similarly treated a week later. Each tonsil will require three to five sittings and then a month's interval should be allowed before further cauterizing, if necessary. In this way, the tonsils can be quite sufficiently reduced and the liability to acute tonsilitis removed. This treatment is especially indicated in adults, with unhealthy though not excessively enlarged tonsils, and in singers.

Scheppegrell remarks — With the electro-cautery snare, we are able to remove an hypertrophied tonsil almost as rapidly as with cutting instruments, without the danger of hemorrhage. In using the snare, if the wire is first tightened, so that when the heat is applied it will not radiate or come in contact with the extra-tonsillar tissue, we will have little pain following this operation.

Electrolysis.—Scheppegrell says: Electrolysis, by means of the monopolar or bipolar needle may be used in hypertrophy of the tonsils, with a current of ten to twenty m. a. for five to ten minutes; the needles being applied to various parts of the tonsil at one sitting.

Draispul says he found it required twelve treatments to reduce the tonsils one-half; and concludes, "electrolysis in the surgery of the nose and larynx is a very slow and unreliable method."

De Tymowski says: In hypertrophy of the tonsils, the results of electrolysis are not good.

Follicular Tonsilitis. C. C. Rice, of New York, cites the following case: *1.* —, aged *15*, came to me October *18*, *1893*. Throat was painful and sore for two days; malaise; tonsils enlarged. ℞. Electric diffusion from copper positive electrode to the throat. October *20*, cured.

2. —, aged *18*. January *18*, *1894*. Temperature *100*°; grayish spots on tonsil. ℞. Copper positive electrode, ten m. a. to every follicle, as well as over the entire tonsil. January *19*, the throat is entirely relieved.

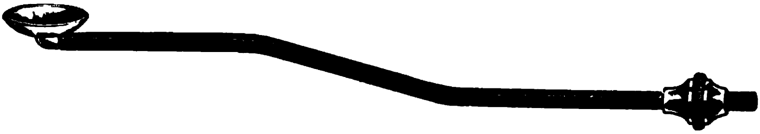


Fig. 138.—Tonsil Electrode.

TONSILOTOMY BY ELECTRO-CAUTERY DISSECTION.

Dr. Edwin Pynchon, of Chicago, says that the operation was designed and first put in practice at his clinic at The Post Graduate Medical School of Chicago, in January, *1890*, in order that flat and degenerate tonsils could be removed in their entirety.

An electric generator is required, whereby the desired heat of the cautery point can be maintained, which he has found to be a nearly white heat, when exposed in the open air. The patient anesthetizes his throat, by swabbing it every minute for twenty minutes with, at first, a ten per cent solution of cocaine and then a twenty per cent, combined with one-half as much carbolic acid as there is cocaine.

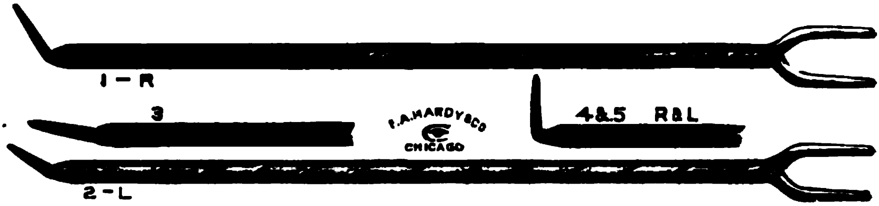


Fig. 139.—Pynchon's Tonsil Cautery Electrode.

In rare cases, deep injections into the pillars and base of the tonsils of a one per cent solution of cocaine, without the carbolic acid, are also used.

The tonsil is grasped with spring tonsil forceps and forcibly lifted from its bed and dissected out in one sitting, which requires from ten to twenty minutes.

Pynchon, in an experience of seventeen years, has applied the hemostat only four times; in two cases to check a hemorrhage which had nearly ceased.

TUMORS OF THE TONSILS.

Sarcoma.—G. B. Massey, of Philadelphia, gives a method of treating malignant tumors by electrolysis and zinc-amalgam cataphoresis. After the local application of cocaine, two treatments were given with two hundred to two hundred and fifty m. a. Later, a small portion of the growth remained, which, after a year, had increased to the size of a peach-stone. The zinc-amalgam bipolar needles were carried deeply into the base of the growth and the treatment was continued for six weeks, when the patient was cured.

A sarcoma of the tonsil, of three years' duration, came under the care of Dr. Freeman, who operated in *1901*. There was a recurrence, when thirty-five exposures to the *x*-ray were made and the growth was reduced in size. Dr. Freeman again operated and there has been no recurrence up to the present time.

Angioma of the Tonsil.—Ballenger advises: Thrust the positive needles into the neoplasm. Apply five to twenty-five m. a. for two to twenty-five minutes at each seance. Repeat once to twice a week. Or use electrolysis: Electric needles may be passed into the tumor and fifty m. a. used. Every minute a few drops of the potassium iodide solution should be injected until twenty minims are used. It should be repeated in eight days, under a general anesthetic.

Hyperkeratosis of Tonsil.—The electro-cautery should be used to destroy it and the surrounding tissues should be penetrated until only healthy tissue remains. From three to four masses may be thus treated at each sitting, at intervals of a week.

A. H. Marvin removed a spindle-celled sarcoma of the tonsil with the electro-cautery knife. There had been no recurrence in six months.

Hamilton reports a pear-shaped tumor (angioma of the tonsil) three inches long, which he removed by the electro-cautery snare.

Scheppegrell says that, in antinomycosis of the pharynx and tonsils, should excision be resorted to, it should be complete and followed by the thermocautery to prevent the spread of the infection.

In a case of mycosis of the faucial and lingual tonsils, which persisted in spite of various local applications, Scheppegrell cocainized the parts and inserted a bent positive needle of pure copper into each growth, with three m. a. of current for two to five minutes. Two applications completed the cure.

CHAPTER II.

THE PHARYNX.

THE EXAMINATION AND TREATMENT OF THE NASO-PHARYNX AND EUSTACHIAN TUBE BY THE AID OF THE NASO-PHARYNGOSCOPE.

We have now an instrument, says E. M. Holmes, of Boston, which I have named the Naso-Pharyngoscope. It can be inserted through the nose into any naso-pharynx into which we can pass a small eustachian catheter, and, by advancing and rotating the instrument when in place, we can examine the whole naso-pharynx, the upper surface of the soft palate, the lumen of the eustachian tube, the posterior portion of the nose, and, in many cases, the opening into the sphenoid cavity. The field is sufficiently large to include the eustachian tube, the space between the anterior lip of the tube and the turbinates, and Rosenmueller's fossa,—with its posterior border behind the tube.

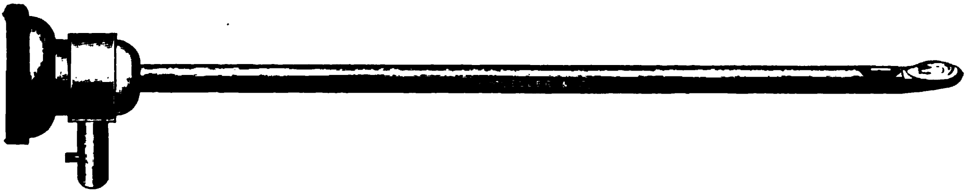


Fig. 139-A.—Holmes' Naso-Pharyngoscope.

With this large field the nasopharyngoscope need not be moved while operating upon any area in or about the tube. Adhesive bands and growths in the lateral fossæ are found and removed under the guidance of vision. I have removed one polypoid growth nearly as large as an orange seed which was attached to the floor of the eustachian tube. It was so far within the tube that I could see it only by the aid of this instrument.

Before passing the instrument, the nose is cocainized. The tube of the instrument is then guided through the inferior meatus upon the floor and at the side of the septum. The fenestra is kept pointing upward until it has passed the posterior border of the septum, when it is rotated toward the opposite side of the epipharynx, from which it enters, which brings the eustachian tube into view. By directing the fenestra upward, the roof and posterior wall of the epipharynx are brought into view, and when the window looks downward, the upper surface of the soft palate is seen. Behind the palate a reduced picture of the larynx is seen. With the fenestra upward, and slightly withdrawn, the posterior portion of the nose is in view and, in many cases, the sphenoid opening.

THE POSSIBILITIES OF THE X-RAY IN THE DIAGNOSIS OF EYE, EAR, NOSE AND THROAT CONDITIONS.

Dr. E. H. Skinner, of Kansas City, summarizes very succinctly the powers of the *x*-ray as a diagnostic instrument, as follows:

1. The *x*-ray stands pre-eminent in the localizing, with exactitude, of foreign bodies in the eye, ear, nose and throat.

2. The x-ray is a valuable assistant in the diagnosis of the pathological changes in any of the bony tissues of the ear, orbit, nose and throat.

3. The *x*-ray gives us definite information regarding the anatomy of those cavities, which cannot be obtained in any other way than through operative procedure.

4. The *x*-ray permits us to study the physiology of speech, singing and deglutition.

5. By the process of diagnosis by exclusion, the probability of sinus involvement will be excluded where we have pains of a neuralgic character.

6. The *x*-ray serves as an assistant in an operaative procedure looking to the extraction of a foreign body from a sinus, cavity, or orifice, by noting that the instrument used to grasp the foreign body is actually attached to it.

A view of the instrument, while operating, can be best secured by means of the fluoroscope.

DISEASES OF THE PHARYNX.

Follicular Pharyngitis.—In follicular pharryngitis, Sajous applies the electro-cautery to six or seven follicles at each sitting.

Lennox Browne cauterizes the enlarged vessels, which supply the hypertrophic lymphoid granules.

Seiss combines both methods when the vessels are large and varicose.

Cupric electrolysis, by means of copper electrodes, is advocated in follicular pharyngitis by Grünwald, who uses fifteen m. a. for ten seconds. He treated in this manner, successfully, cases which had not yielded to the electro-cautery and chromic acid.

Pharyngitis Hyperplastica. — Ballenger says that in well advanced cases the lymphatic nodules should be punctured with a cherry-red cautery electrode, after applying a ten per cent cocaine solution. Four or five follicles may be treated at a time, at intervals of five days.

Granular Pharyngitis.—De Tymowski says that in granular pharyngitis the disappearance of the granulations is effected by electrolysis, without the trace of a cicatrix.

Tertiary Syphilitic Ulceration of the Pharynx.—In this disease, Lennox Browne uses the electro-cautery, which has superseded the use of mineral caustics in his practice. In specific ulceration of the nose he had two cases, in which threatened destruction was arrested by the electro-cautery, when other means had failed.

Indolent Patches.—Scheppegrell, in the treatment of indolent mucous patches, which had resisted the usual constitutional treatment, applied the negative pole, attached to a pledget of cotton, saturated wih a strong solution of salt water. The result was successful.

In a similar case, the same method caused the patches to disappear after five applications, at intervals of three days.

Paralysis.—In paralysis of the muscles of deglutition, Schech applies a negative galvanic electrode directly to the paralyzed muscles and the dispersing electrode to the neck.

Polypi. — Schmithnisen reports five cases of polypi in youths of seventeen or eighteen. Hemorrhage brought them to the doctor. A single application of electrolysis, with Voltolini's burner, stopped the bleeding permanently. The throat part of the tumor was snared from the mouth; the snare was then connected with the negative pole, while the positive was placed on the cheek.

After twenty or twenty-five minutes both poles were connected with the snare and the tumor was slowly burnt through. The upper part of the tumor was left, but electrolysis was applied to it through the nose every ten or fourteen days.

Adenoids.—L. Rousseau, of Brussels, devised and used an electric curette of wire, which is heated as a cautery, to remove adenoids. He thinks this the safest method.

Garel describes an electric snare which he employs: The terminal barrel of the snare takes the form of Gottsteius' knife, the cutting portion of which is replaced by a metal loop so grooved that the snare lies concealed within a trough when prepared for introduction into the naso-pharynx.

As soon as the growth is felt to be engaged in the instrument, the electric current is closed and gentle traction made on the finger-hold attached to the wire, which then leaves its place of concealment. The operation is completed by alternate closing of the circuit and traction on the wire.

Angioma.—Ballenger says: "If the angioma is small apply ten per cent cocaine; introduce the positive needles into the growth; turn on ten to twenty-five m.a. for five minutes. Repeat weekly, until the growth is obliterated."

Rogers says: "Small and medium-sized tumors, in reasonably accessible locations, are best removed by the light. The pad should be thick; bring the lamp close and destroy the tissues deeply. The slough will separate in a few days and the wound will heal without a scar."

Fibroma of the Pharynx.—Ballenger says that small growths, especially if they are pedunculated, and those limited to the epipharyngeal space, may be removed by the galvano-cautery snare, either through the nose or the mouth.

Electrolysis has been strongly recommended by Groenbech, who records seventeen cases of fibroma of the larynx out of thirty-two treated in this way by different operators.

W. J. Morton, of New York, makes a strong plea for *x*-ray radiations prior to operation in cancer of the larynx and pharynx. He sums up the advantages thus:

1. Radiation retards the growth of some cancers.

2. It cures some cases.

3. Pre-operative radiation will increase the ratio of cures by operation.

4. It transforms some inoperable cases into operable.

5. It is recommended as a precautionary measure, probably, quite as important as antiseptic preparation for surgical operation.

M. B. Ahlborn, of Wilkesbarre, Pa., gives the report of one hundred and seven cases, treated by radiotherapy, *1904*:

Epithelioma Cutis.—On the nose, eleven cases, all cured.

Ear.—Two cases, cured; sarcoma on the ear, one case, cured.

Epithelioma of the Throat.—Six cases, one cured, which had recurred on the tonsil after operation.

Epithelioma of the Nose.—Four cases, cured.

Epithelioma of the Tongue.—Draispul, of St. Petersburg, cites a case successfully treated by electrolysis. The patient had an ulcer *2.5* x *1* c. m. with involvement of the cervical glands. A negative steel needle was used with twelve m.a. Six seances. Three months later the tongue had healed and the enlarged glands had disappeared. No recurrence in a year.

Groh attributes the disappearance of the enlarged glands to the catalytic effect of the current, at a distance.

Lingual Varix.—Ballenger says: "Apply the galvano-cautery to the enlarged veins and remove the hypertrophied lymphoid masses with the cautery point or scissors. Apply glycerine, tincture ferri chlor. and tinct. iodine daily."

In a case in which the electro-cautery was unsuccessful Scheppegrell obtained a cure by using cupric cataphoresis.

Elongated Uvula.—F. A. DeBlois, of Boston, states that the pain and reaction from the electro-cautery are less than from any other method.

Paresis of the Velum Palati.—A case of six months' duration, which followed an apoplexy, was treated by Gessler, Stuttgart, with galvanism and resulted in a cure after seventeen sittings.

Leukoplacia of the Cheek and Tongue.—E. Fletcher Ingals, of Chicago, recommends the use of the electro-cautery and advises treating a small area at each sitting and avoiding the destruction of underlying healthy tissue.

Enlarged Glands.—R. H. Boggs, of New York, writes that glands enlarged after typhoid, measles, etc., can be cured by means of the *x*-ray. Supplementary glands should first be incised.

When patients have been subjected to the ordinary treatment without avail, the glands should be rayed intensely. In the treatment of over twenty-five cases, following operation, experience showed that it is necessary to begin *x*-ray treatment more gradually.

Fistula of the Neck.—A fistula of the neck, between the hyoid and thyroid, six and a half c.m. deep was cured by Lichtwitz, who used a metal electrode, one m. m. in diameter, attached to the negative pole. Applications were made at intervals of one to two weeks. There was no recurrence at the end of ten months.

REMOVAL OF METALLIC FOREIGN BODIES FROM THE OESOPHAGUS BY THE AID OF THE X-RAY.

C. E. Allen, of Cincinnati, reports two cases:

1. A child of four years swallowed a cent, which an *x*-ray showed below the larynx. An assistant, looking through the fluoroscope, retained the coin in view and gave direction to the operator, who removed the coin with the laryngeal forceps.

2. A boy of five years swallowed a round flat tin whistle. The same method was pursued as in the former case. In ten minutes, the wind instrument was removed.

It was necessary for the assistant to view the neck from the side, in order to direct and be out of the way of the operator.

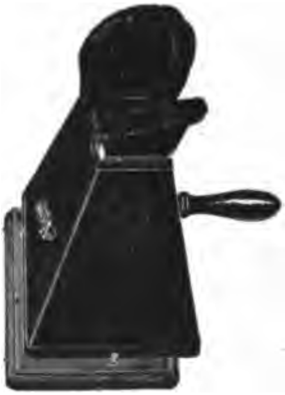


Fig. 140.—The Fluoroscope.

The Oesophagoscope.—Sidney Yankauer, of New York, cites four cases in which foreign bodies in the œsophagus were removed by the œsophagoscope:

1. A round body was located just above the sternal notch by means of the flouroscope. A short Killian tube was passed, the penny seized and withdrawn with a forceps.

2. A figure of a rooster—a toy—six by fifteen by twenty-one m.m. was removed.

3. An attempt to remove the penny without the œsophagoscope had failed, but with it, was easily removed later.

4. A piece of brass, seventeen by six by eight m.m., was swallowed. Upon the third attempt, the foreign body was removed. The boy died three days subsequently.

Electro-Magnet.—Garel, of Lyons, reported the case of a child who swallowed a nail. After a radiographic examination, tracheotomy was performed. A very strong electro-magnet was held

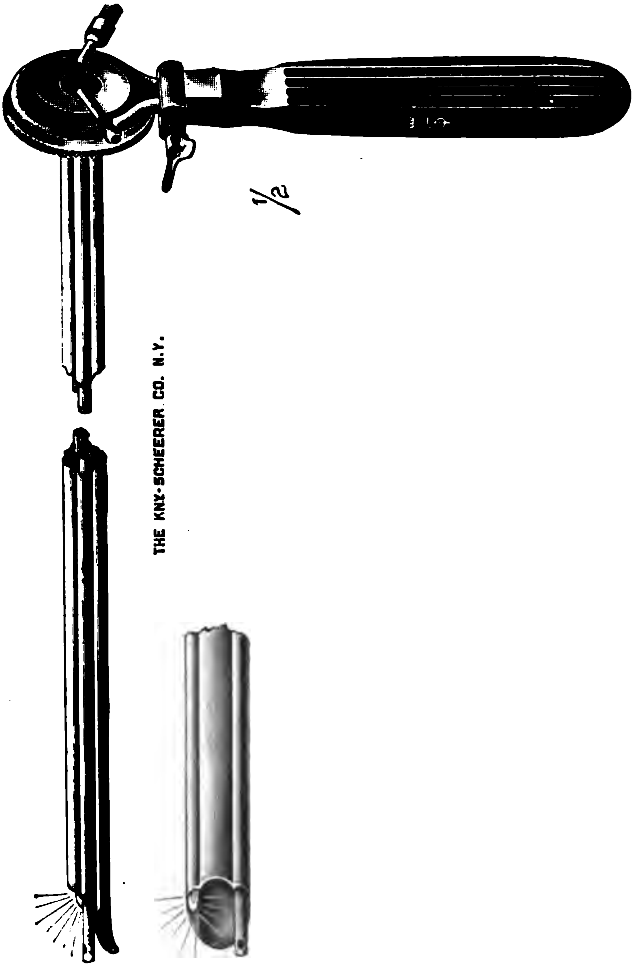


Fig. 141.—Lerche's Improved Oesophagoscope.

near the tracheal opening. The nail sprang to the magnet at once and was easily removed.

STRICTURE OF THE OESOPHAGUS.

W. H. King reports six cases of stricture of the oesophagus treated by electrolysis. One was cancerous, and the patient was enabled to swallow liquids, which he had been unable to do previously.

The second was chiefly spasmodic, in which the result was unsatisfactory.

The third was cicatricial, and was cured. Eighteen months later food could be swallowed without difficulty.

In three fibrous cases the results were successful. The negative oesophageal electrode is used with a large positive dispersing electrode on the back or chest, with three to five m.m. of current. The size of the electrodes should be gradually increased, as in dilatation.

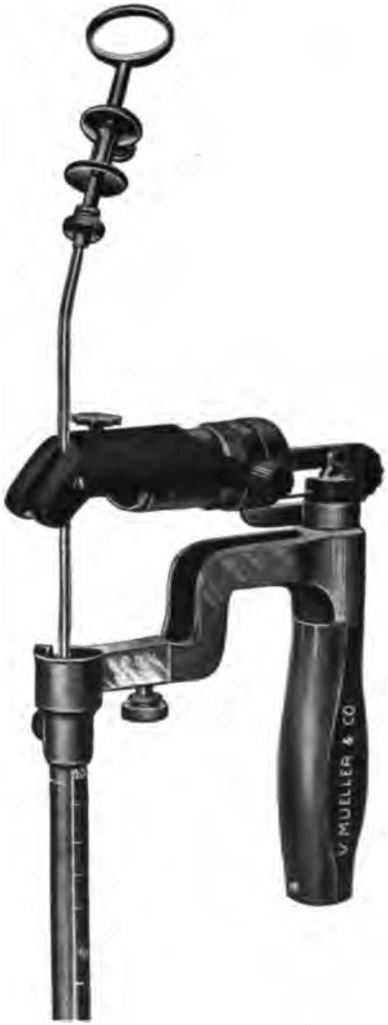


Fig. 142.—Bruening's Electroscope. To be used in connection with laryngeal, bronchoscopic and oesophagoscopic tubes. It admits of the use of operating instruments without interfering with the lighting system.

CHAPTER III.

THE LARYNX, TRACHEA AND BRONCHI.

Neuroses of the Larynx.—W. H. King recommends in general weakness of the laryngeal muscles, atrophy of the muscles from over use and passive congestion of the vocal cords, the interrupted galvanic current, applied by one small oval electrode over the posterior border of the thyroid; the other electrode is placed posteriorly to the arytenoid cartilage over the carotid artery.

Laryngeal Paralysis.—Massucci reports a number of cases of laryngeal paralysis cured by vibratory massage.

Hysterical Aphonia.—In acute cases, Scheppegrell directs the patient to count ten, while a faradic current is passing through the neck; the electrodes being applied to both sides of the larynx. One sitting is sometimes sufficient to restore the voice.

In chronic cases of hysterical aphonia, he adds to the above galvanism and if the external method is insufficient, the negative electrode is applied within the larynx, and the positive externally.

Bi-lateral Abductor Paralysis.—Wingrave reports the case of a boy of seven years, who had aphonia, probably hysterical, which had persisted for four years and the voice was permanently restored with one application of the interrupted current.

I have repeatedly restored the voice in case of aphonia from mild laryngitis by a few treatments over the larynx with the application of the vacuum electrode of the high-frequency current.

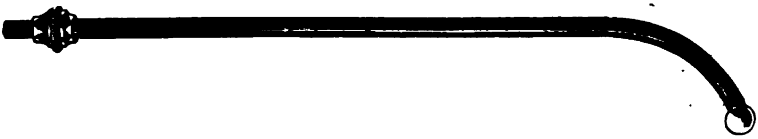


Fig. 143.—Laryngeal Electrode.

Acute Laryngitis.—Rogers says that unless there be marked oedema, the light rays relieve in a few minutes. The rays should be applied over the throat, sides of the neck and upper part of the chest. The lamp should be brought close to the skin and moved enough to prevent blistering. Continue for twenty to thirty minutes.

Chronic Laryngitis.—Commence, says Rogers, with the lamp at a comfortable distance and bring it gradually nearer, until the patient complains of the heat. Repeat for fifteen to twenty minutes daily. In faulty metabolism, give general application.

Laryngeal Papillomata.—Case *2.* —, aged six, had a tracheotomy two years previously. Larynx is now the same as when operated upon. Eight *x*-ray exposures were given in eight days. Improvement began after five days of treatment, which is to be continued.

Pachydermia Laryngis.—Scheppegrell says that the treatment which is most highly recommended is bipolar electrolysis, with ten to fifteen m. a. of current at a time. Others recommend the galvano-cautery, but it must be used in the larynx with the greatest caution.

Chiari strongly recommends electrolysis, when the growth is situated upon the vocal cord; ten to twelve m. a. being used for three to five minutes.

Cautery in the Larynx.—Gottstein and Lennox Browne do not favor the use of the electro-cautery in the larynx.

Scheppegrell remarks that other laryngologists have had good results from the application of the electro-cautery in the larynx and that he has used it successfully, in several cases of neoplasms in the larynx; and at no time with unpleasant complications due to the use of the cautery.

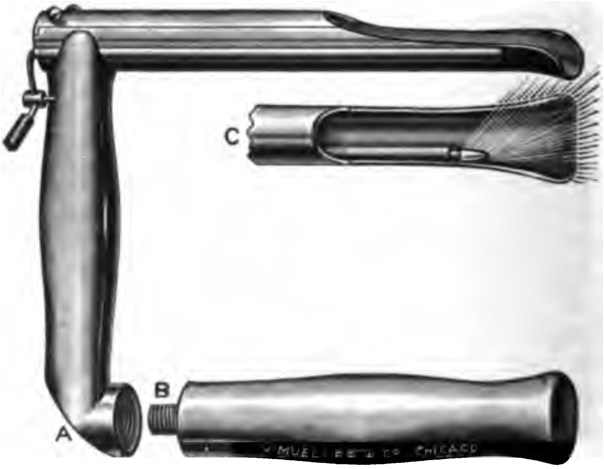


Fig. 144.—Jackson's Laryngeal Specula. Modified by Dr. R. H. Johnston.

Necrosis of the Left Arytenoid Cartilage.—Scheppegrell reports a case in which an excessive amount of granulation tissue developed at the site from which the necrosed cartilage had been removed, and persistently recurred after removal with the cold snare and forceps. The electro-cautery was then applied and the diseased tissue carefully extirpated, which resulted in a permanent cure.

He advises that, in using the electro-cautery in the larynx the point be very fine, so that it may be instantly heated and as quickly cooled; which is necessitated by the possibility of a laryngeal spasm in spite of cocainization.

TUBERCULOSIS OF THE LARYNX.

Sinclair Tousey, writing in *1904*, says: Revellet, in *1897*, reported a case of acute pulmonary and laryngeal tuberculosis, treated by the Roentgen Rays. Sleep was improved; temperature became normal and the dysphagia disappeared.

The patient died.

Treatment by the violet and ultra-violet rays of the electric arc light has been employed by Dr. Fruedenthal. Most of his cases showed extensive lung lesions. In every case there was marked relief from pain and dysphagia, but in no case was there any perceptible effect upon the tuberculous infiltration or ulceration.

Freudenthal cites the following case in *1900*:

—, aged *19*; phthisis of the lungs and larynx; deep ulcer on left cord. Treatment, creosote, etc. Electric light tri-weekly to left side of the larynx.

The ulcer healed in three months and the patient is free from pain.

According to German authorities the electric arc light has given the best results.

Treatment by the Galvano - Cautery. — Schmithnisen, of Aix-la-Chapelle, says that the burner was introduced six, eight or ten times at a sitting if necessary, and a very high degree of heat was used. Pure lactic acid was applied immediately after the cautery; or, in case of large infiltrations, chromic acid to the slough and neighboring parts. The great thing is to penetrate to healthy tissue.

Three or four weeks should elapse before the cautery is reapplied to the same place. Both false chords may be cauterized at the same sitting. Lactic acid may be applied between times.

Twenty-seven cases were treated in this way and cured. All are still living. One patient, who had endured ninety applications of lactic acid and three cuttings, was cured in three months by four applications of the cautery.

By the same method, two cases of lupus of the larynx with stenosis had been cured; in one of which, laryngo-fissure had been proposed.

Mermod writes: Surgical treatment is demanded so soon as infiltration exists. Laryngeal electrolysis has been successful in a number of cases. Galvano-cauterization avoids both hemorrhage and edema. The instrument should be delicately constructed so as to give a good view of the field of operation. An injection should be given of morphia twenty minutes before cocainization. The cautery needle is to be thoroughly plunged into the diseased tissue and allowed to burn continually or intermittently till a cavity is formed. At least two weeks should elapse before a second sitting.

Out of two hundred and eighty, many of whom did not continue treatment, sixty healed for one year or less; forty for two years and seventeen for three years.

Electrolysis.—Scheppegrell, in tuberculosis of the larynx, prefers cupric electrolysis, by means of the positive electrode of pure copper applied to the diseased areas. The electrode is spherical, one-eighth to one-quarter inch in diameter.

He has rarely found more than five m.a. to be necessary. He applies it every second day.

De Renzi, Naples, recommends percutaneous galvanism by means of large electrodes and strong currents. He states that in all cases treated, there was a marked increase in weight, diminution in fever and in the number of bacilli.

Heryng considers that, in tuberculosis of the larynx, electrolysis is more apt to be successful than any form of cauterization.

DIPHTHERIA.

The following cases were reported by Dr. J. W. Devoreaux, of St. Louis. He saw a malignant case of diphtheria early and gave anti-toxin. The child died.

A second child, in the same family, was attacked with the same severity. He applied the *500* c.p. lamp and in ten minutes there was improvement. The case recovered rapidly.

Many similar cases have been reported.

Unless there is noticeable improvement in twenty to thirty minutes, anti-toxin might also be used.

Stenosis of the Larynx.—M. Bonlay, of Paris, cites the case of a young man, aged nineteen, who had had a tracheotomy performed at the age of three, and had had to wear a canula ever since. A glottic and subglottic retraction were formed leaving a very narrow passage for air.

Treatment by rapid dilatation, by slow dilatation, by galvano-cautery, and by punch forceps had been of no avail. Repeated applications of intralaryngeal electrolysis succeeded for a few months in creating so large a passage that the canule could be removed.

Mycosis.—Lee M. Hurd, of New York, reports a case in which the throat was exposed to the rays through a speculum and from the outside through the neck. The patients had forty-one exposures to the X-ray for ten minutes, with a spark-gap of three inches. Commencing treatment May *25*, *1903*, there were no spots to be found by Dcember *29*, and there has been no return to the present—*1905*.

MALIGNANT DISEASES OF THE LARYNX.

Cancer of the Larynx.—Cured by the *x*-ray. On April *19*, *1902*, a man, aged *57*, came under the care of Dr. Scheppegrell. Six months previously, he had developed a hoarseness. A tumor is seen on the left wall, involving the left vocal cord. It is of a dirty gray color. June *9*, the tumor had grown so large that normal respiration was impeded. The odor of cancerous disease was now marked and ulceration had set in. The glands were not involved. The patient declined operative treatment and decided to try the effects of *x*-ray exposures.

A medium vacuum tube was selected. The face and chest were protected with prepared paraffin paper, so as to utilize the effects of the treatment on the neighboring tissues and the lymphatic glands, in the event that these had been involved.

The head was well bent back to allow the *x*-rays to be projected directly through the skin and cartilage into the diseased tissues. The first treatment was at fifteen inches from the target for two minutes. Repeated every day after for twenty minutes and the distance was gradually reduced to seven inches. The target was brought to a dull red heat. The pain disappeared after the second exposure and did not recur. After the twentieth application the patient was sent home, it being understood that unless some marked benefit should occur ten days later the treatment would not be continued. Six days later, a letter stated that the patient appeared considerably worse. A few days after the patient wrote that he had been benefited and would return on July twenty-fourth.

The whole mass had disappeared, including a large portion of the left vocal cord. X-ray treatment continued for ten days, at which time the ulceration had completely healed.

October *23*. In excellent condition.

Scheppegrell states that he believes this to be the first case of malignant disease of the larynx cured by the *x*-ray.

Laurens, writing in *1909*, reports two cases, in which the operation was performed only a month before the report. The convalescence was rapid in both cases.

He describes the method of Keating-Hart: First, the microscopic removal of the growth, without any attempt at its entire obliteration and of the surrounding tissue. Secondly, fulguration for five to ten minutes under chloroform and cocaine to prevent movement of the larynx.

Non-Malignant Growths.—Pieniazek, Kraken, reports the case of a growth which filled the trachea. A small opening was made in the trachea, through which a mirror was passed to locate the growth, and repeated applications of the galvanocautery resulted in a cure, leaving a normal voice.

Lupus.—Semon reports a case in which repeated electro-cautery punctures succeeded in curing the laryngeal affection which had caused aphonia.

TRACHEITIS.

Dr. W. G. Schauffler, of Lakewood, N. J., advocates the use of the blue light energy, and cites an illustrative case:

The apparatus, he says, consists of a series of incandescent lamps of sixteen, thirty-two and fifty c.p. with reflectors, cords and stand, and glass bulbs of dark blue glass, through which the light has lost much of its heat. What rays pass through the blue glass remains to be shown.

....I attach the lamps to a *110* volt lighting current, either direct or alternating; the reflector is held six to eight inches from the part to be rayed. Burns of the skin have not resulted from the use of the light.

Case *5*. Tracheitis. J. M., aged *15*, had a tubercular family history and was a hemophiliac. A slight cold would set up a high temperature with paroxysms of violent coughing and severe pain, apparently between the larynx and the bifurcation of the trachea.

All sorts of internal medication, as well as inhalations, failed to give relief in previous attacks.

Within six hours after the commencement of the last attack, the Minim rays were applied from a thirty-two c.p. lamp, held twelve inches from the neck for fifteen minutes at a time. Repeated every four to six hours without any medication. The first treatment relieved the pain, and within twenty-four hours, the cough had ceased to irritate. The rise of temperature, which had always followed the beginning of such attacks, did not appear and the patient was up and about on the third day.

Case *6*. Mrs. T., aged *36*. Phthisis and tuberculosis of larynx. This case was referred by a throat specialist, with request to touch the cords with a strong solution of nitrate of silver. This treatment usually causes much pain and choking. It occurred to me to try the Minim rays, applied to the neck before treating with the nitrate of silver. The result was that the patient no longer felt the pain of the treatment and the choking was reduced to a minimum.

BRONCHOSCOPY AND OESOPHAGOSCOPY.

A personal communication from Dr. J. R. Fletcher, of Chicago.

Of the noteworthy uses of electricity in the specialties, illumination attracts our attention at once. Perhaps the greatest feature in this field, apart from the *x*-ray, is bronchoscopy. Without electric illumination, bronchoscopy would, today, be an impossibility. With it, we are able to do astonishing things.

Before the introduction of bronchoscopy, the only means of removal of foreign bodies in the trachea, bronchi and oesophagus was by major surgery, which was, and still is, very unsatisfactory. In the unknown cases, that is cases in which no history of aspiration or swallowing of a foreign body could be had, nothing was done with reference to such a possibility even when the symptoms pointed to obstruction or to great or even prolonged irritation. Today, in competent hands, such cases are skiagraphed, and, whether the history be positive or negative, the patient is examined with the bronchoscope or oesophagoscope, with, frequently, the most happy result.

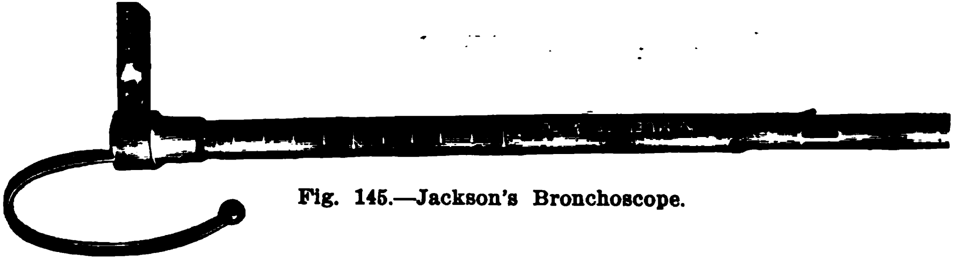


Fig. 145.—Jackson's Bronchoscope.

To illustrate this point, namely, the great usefulness of electric illumination of the trachea, bronchi and oesophagus, I will outline a few cases:

I was requested by Dr. Long, of Chicago, to see with him B. L., aged four years, three months, who suffered at the time from severe dyspnea and regurgitation and coughing up of fluids swallowed. Solids could not be swallowed.

Eighteen months previously the child was said to have swallowed a button from its overcoat; a picture button. Such buttons are made of metal back, celluloid (*1/5000* inch thick) front and button-board cardboard between. This history was lightly thought of by attending physicians, especially as the skiagraph showed nothing.

The child complained of sore throat and, for a week, could swallow only liquid food. No trouble was noticed thereafter for ten months, when the child suddenly developed great dyspnea and later broncho-pneumonia. The dyspnea was so great that a local surgeon performed tracheotomy. Partial recovery was made, the tube remained *in situ*. A diagnosis of weak lungs was given.

I first saw the child eighteen months after the time of the possible swallowing of the button. Because of the coughing up of the milk which had been swallowed, together, of course, with the history, I believed the button to be in the oesophagus and thought it had ulcerated through the trachea.

Under general anaesthesia, the trachea was explored with the Bruening bronchoscope through the tracheal incision; that is, by low bronchoscopy.

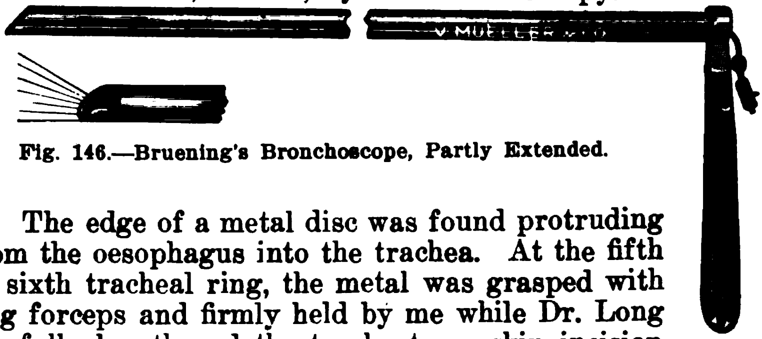


Fig. 146.—Bruening's Bronchoscope, Partly Extended.

The edge of a metal disc was found protruding from the oesophagus into the trachea. At the fifth or sixth tracheal ring, the metal was grasped with long forceps and firmly held by me while Dr. Long carefully lengthened the tracheotomy skin incision as far as possible, and then, by blunt dissection, freed the trachea and oesophagus down to the button. I then grasped the button between the trachea and oesophagus and removed it by a slight rotary and pulling motion.

This child made a complete recovery, though it was necessary for it to wear the tracheotomy tube for some weeks. Without a good light, this procedure would never have been attempted; and but for the electric illumination we would have no bronchoscope.

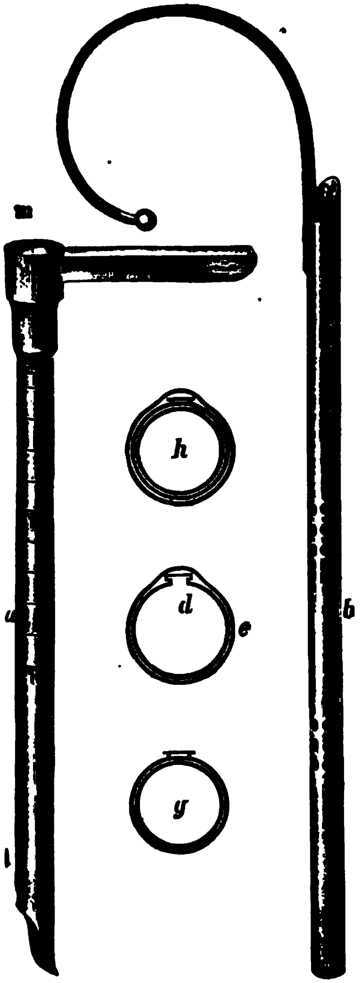


Fig. 147.—Parts of Bruening's Extension Bronchoscopes and Oesophagoscopes, used in connection with Bruening's Electroscopes.

I am convinced that many cases go to their graves for want of an inspection, which it is now in our power to make.

Prof. Killian, then of Frieburg, told me that more foreign bodies had been removed from patients in his clinic than in all other parts of Germany together; due to the alertness of physicians within a radius of a hundred miles of his dispensary.

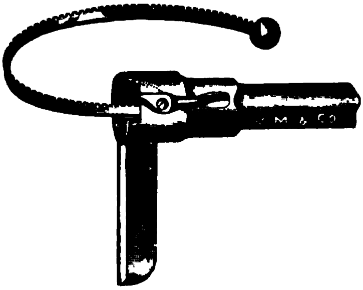


Fig. 148—Locking Device.

Another case, illustrating the desirability of looking directly at the part complained of, is that of a woman sent to me with a diagnosis of asthma. I noticed that both inspiration and expiration were equally labored and at once thought of obstruction. There was no foreign body history. The patient had had diphtheria five years previously. High bronchoscopy, under cocaine, revealed a web-like stricture of the trachea, an inch or so above the first bifurcation. The central opening was about the size of a lead pencil. Such cases can be easily relieved by dilatation, V-shaped incisions, or both—and this promptly. Patients thus affected are removed from a state of invalidism to one of health very rapidly.

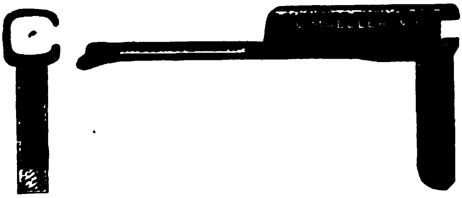


Fig. 149.—Bruening's Open Spatula for Infants and Small Children.

I remember a case of Prof. Killiam's suffering for a long time from bronchorrhœa of the severest type. Every diagnosis that could be thought of had been made. He was at last sent to Freiburg, where a history of swallowing three tacks, six years previously, was obtained. The patient insisted that no such thing could be there as he had coughed them up.

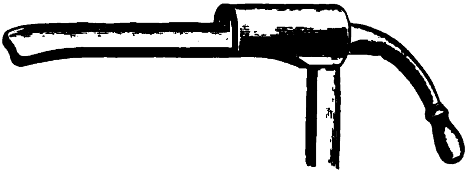


Fig. 150.—Bruening's Suction Spatula.

The man was an upholsterer, and after the habit of his craft, he had for convenience filled his mouth with tacks. He must have swallowed four, as the *x*-ray showed a large-headed upholsterer's tack in the left bronchus, shaft upward.

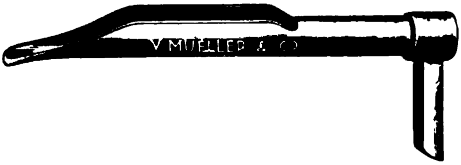


Fig. 151.—Bruening's Autoscopic Spatula.

Bruening devised an instrument for dilatation of the stricture. It was complete up to the shaft and removed the object, than which, there could be no more difficult operation.

Many other interesting cases can be found in the literature reported, notably by Moyer, of Boston; Jackson, of Pittsburg; Casselberry and Ingalls, of Chicago, and others.

Malignant and other diseases of the trachea and oesophagus and nearby parts can be more certainly diagnosed by this means which direct electric illumination has placed in our hands. The day of radical surgical removal of foreign bodies has passed and the dawn of the time when many more cases will be looked at directly, through the means under present discussion, has come.

ELECTRIC LIGHT IN DISEASES OF THE RESPIRATORY ORGANS.

W. Freudenthal, of New York, says: "After it had been known that cultures of tubercle bacilli were destroyed by the sunlight (R. Coch) it was found that the arc light contained more ultra-violet —i. e., bactericidal rays than even the sun, and therefore afforded equal or even better results than sunlight. When electric light or sunlight has been applied to the deeper parts of the organism, the bactericidal result has been nil.

"I have a long list of patients that I have treated for tuberculosis of the lungs and throat by means of electric light. While the great majority liked the treatment and asked for it, I can see in the electric treatment only an adjunct to the host of other remedies at our disposal; an adjuvant that is of great assistance to us in the management of some cases of tubercle."

HAY ASTHMA.

As in Hay Fever and Hay Asthma, the neurotic element is almost invariably an important factor, the effect of the electric light treatment has been more conspicuous. I have had patients come into my office with rales all over the chest; constant sneezing, etc., who left a half hour later with no rales to be heard and with a slight coryza only.

A colleague has told me that he obtained the same results with a high-frequency current. One of my patients came to me after he had been treated by the static current in vain and I was enabled to afford him the most marked relief immediately. I generally apply electric light to the face indirectly, by letting the rays pass through a blue screen. The heat of the light in summer would be too intense to bear for any length of time on the face. During the last two years I have treated twenty-four patients with hay fever. Out of these, fourteen experienced decided improvement in all respects, very soon after the treatment was commenced. In some cases, the profuse discharge from the nose, sneezing and asthma were relieved right after the first exposure to light.

All these fourteen patients could stay in the city and attend to their business, but, of course, had to come for treatment regularly. Six out of these were treated for two seasons and it seemed as if all had much weaker attacks the second time than in the previous year. The remaining ten improved but little or left off treatment too soon to form an opinion.

The following case will serve as an illustration:

Mr. C. R., aged *35*, came to me September *9*, *1900*. A year before, he was attacked for the first time by hay fever, etc., and, this year it commenced as early as August *6*, at noon. He had all the symptoms in an aggravated form; sneezing, running of the nose, asthma, insomnia, loss of appetite, etc.

I applied suprarenal extract to his nose and exposed him to the light, when he professed to feel like a new man. Besides I gave him N. Cl. to take and in two days he went to business again. I saw him every two or three days till the beginning of October, when he had had no further trouble.

The good result in this case was so much the more remarkable, as he had been subjected to all sorts of treatment, previously, without benefit.

The following year I began treating him on July *16*, in order, if possible, to avoid a recurrence. We succeeded to a certain degree as the symptoms were much less marked. Only from September *4* to *7*, he felt quite heavy. At other times he had slight sneezing and rattling in his chest.

After the foregoing, I consider myself justified in declaring the electric light treatment a most important factor in combating the symtoms of hay fever.

The study of light has brought forth, and will, in the future bring forth more beneficial effects not only in the treatment of disease but in its prevention.

Hay Fever, treated by the *500* c. p. lamp.

Rogers says: "Early in the attack the disease may be aborted by one application of the *500* c. p. lamp, during one-half hour to one hour. It should extend over the whole body, but especially, to the throat, face and chest. Repeat twice daily until recovery. In certain old cases, the disease may return once. After the second course of treatment, the patient is generally immune. This is an illustrative case:

"Miss —, aged *19*, has a tubercular family history, but is in good physical condition. She has suffered for two years from hay fever. Had a very severe attack lasting all the last night. The lamp was applied for fifteen minutes with entire relief. Treatment was repeated daily for a week. Condition then became normal. The treatment was continued three times a week for three weeks. There was no recurrence. Reports of a large number of cases. treated thus, are very favorable."

Hay Fever, treated with high-frequency current.

F. C. Tice, of Roanoke, Va., says: Seven cases of hay fever were treated with bland oil atomization, after which, an insulated low vacuum tube was attached to a high-frequency coil and applied to each nostril for ten minutes.

The most acute case was cured by two treatments; four cases by one, and two, with asthma, were relieved by the first treatment and cured after five or six administrations.

Technic.—I used a low vacuum insulated nasal electrode, using at first just enough current to produce a very short spark."

Eugent S. Yonge, writes: "Among other methods of treatment which have been found useful in hay fever are high-frequency currents, electrolysis and galvanism. It is a good general rule to employ such measures as the cauterization of the nose for the relief of hay fever only when there is local obstruction, or when there are definite hyperæsthetic areas in the nose. In the latter case, a good general plan is to make one or two linear burns on the anterior part of each inferior turbinate and the anterior part of the septum on each side at the level of the anterior end of the middle turbinal for one-half inch. Several applications will be required, but only a single burn should be made at a time, and with a week's interval. This treatment should be carried out in March or April, and it may be necessary to repeat it in successive years.

CHAPTER IV.

EXOPHTHALMIC GOITRE.

EXOPHTHALMIC GOITRE TREATED WITH THE X-RAY.

C. Thurston Holland, having dealt with twenty cases, offers the following conclusions:

1. The pulse rate was nearly always reduced and this almost at once.

2. The tremors and nervous symptoms improved from the start.

3. The gland noticeably diminished in size in some of the cases; remaining unaffected in others; but if hard, tense and throbbing, the throbbing diminished and the gland became softer.

4. The exophthalmos was not materially altered.

I also called attention to the fact of myxoedema supervening, as evidenced in two cases; and I suggested that only one side of the gland should be treated, at any rate, vigorously. While we had browning and, occasionally, redness of the area of skin exposed, in those cases, where three or four layers of boiler felt had been interposed between the skin and the tube, no skin effect followed.

Exposures of five to ten minutes were given. Of course, this statement conveys no information to other workers. The exposures were given alternately to either side of the neck, daily or every second day.

Since the above series, our department has dealt with about twenty more, all of which, if the treatment was continued for a long enough time, have derived considerable benefit. I will dwell upon six of the cases only:

1. E. C., aged *28.* Came May, *1908.* Glandular swelling of a few months' duration, and prominent eyes. From June *1,* to January *4/09,* she had sixty-five exposures of ten minutes to the right side of the gland. On February *5/09,* "Very much better in every way." The prominence of the eyes has markedly diminished. No palpitation. The gland has diminished in size. Between June 1 and July *1,* the pulse dropped from *124* to *94.*

Case *3.* M. G., aged *28,* June *15/08.* Eyes have been prominent for eight weeks; neck swelled for three months. The neck measures *13* inches. Pulse is *108.* Forty-three exposures of ten minutes caused steady improvement. Thyroid and exophthalmos gradually diminishing. July *28*—In one week, the patient has gained two pounds. Took Calc. Lact. grs. *4*; Soda Phos. gr. *44* t. i. d.

Case *4.* H., aged *45.* June *25/08.* The patient has had symptoms for seven years. The neck is *15.4* inches. No exophthalmos. Between July 1*/08* and February *5/09,* the patient had forty-one exposures of ten minutes, to the right side of the neck. February *5/09,* the neck is *13.5* inches. She can do more than she did without exhaustion and feels very much better.

Case *5.* L. H., aged *25.* The duration of her illness was four or five years. She cannot continue her work as a telephone girl. May *18/08,* the pulse is *124.* Resp. *36.* Marked exophthalmos; neck *14* inches. Treatment, *x*-ray fifty-four times in hospital, from May *18* to August *21.* Steadily improved.

On December *17* she resumed her duties. February *13*, neck is *14* inches. From a thin girl she has become quite fat and the neck, in consequence, has increased in size. She says she can work better than ever, and has lost all her puffing and blowing and can run up and down stairs. The exophthalmos is not noticeable. Just after a railroad journey, the pulse is *104*.

Case *6*. M. A., aged *25*. April *11/08*. The neck has been enlarging for eighteen months. The eyes have been prominent for twelve months. The neck is *14½* inches. Marked exophthalmos; badly nourished. She remained in bed, in hospital, from April *11* to July *1*, under medical treatment, with Leiter's tubes, potassium bromide, thyroidectin, iodides, iron and other things being used. She steadily went from bad to worse, losing weight all the time, and all the symptoms increasing in severity.

When x-rays were suggested, on July *1*, the patient was extremely ill. Her weight was *121* pounds. Marked exophthalmos, throbbing in carotids; constant vomiting, and her condition getting worse each week. Dr. Hay, who was in attendance, thought she was going to die.

The *x*-rays were applied first on July *1*, and up to July *30*, she had had twenty-five ten-minute exposures, at first, to one side, then, alternately to each side. July *18*, the patient is greatly relieved. No vomiting for several days; has gained four and one-half pounds in the last week. From August *1* to September *2*, she has had thirty-one exposures. She then relapsed and lost eleven pounds in one week.

This passed off, and from September *28* to October *10* she had eight exposures; and, on October *18* she was so much better as to be able to go home. December *7/08* to January *18/09*, she had eight treatments.

February *9/09*, she came to report, and we did not know her, she was so fat and well looking. The neck was *14* inches, due to flesh, as the gland was greatly diminished. The pulse was *88*, after the exertion of coming to the infirmary.

In not one of the cases did the skin even brown, much less redden. This is of vast importance.

I note, in a paper by Pfahler, of New York, that he says: "The treatment should be localized upon the goitre and may be carried to the point of producing a milky dermatitis, but not more." This is a dangerous doctrine and an unnecessary one. In any case which I have had to treat, in which it was not necessary to affect the skin, I have, for some time, used boiler felt, as a skin protection. In not one single case have I ever seen even any redness of the skin supervene. On the other hand, as evidencing the danger of Pfahler's dictum, on December *10*, of last year, I saw one of the cases of goitre, which we had treated in */06*, on and off from January *22* to August *22*. She had had forty-one treatments, alternating, and yet, this girl, who had had slight redness of the exposed area following this, but nothing else, when she presented herself, eighteen months later, although cured of the exophthalmic goitre, had an extremely ugly telangiectasis, which was progressing over the whole of the skin area exposed and which was very disfiguring.

It seems to me that no case of exophthalmic goitre ought to be operated upon until a complete and satisfactory trial of *x*-ray has been made. It will be of no use to do this tentatively, and, after a few weeks giving it up as being of no use and rushing into operation. Before this conclusion is arrived at, it is necessary that a long continued course shall have been conducted by a skilled specialist.

Holland thinks that anyone who had seen a patient die forty-eight hours after operation for goitre would hesitate to recommend an operation before trying *x*-ray treatment.

Dr. Reginald Morton said that his experience at the London Hospital bore out what Holland had stated, but that he had not noticed so regularly a reduction in the exophthalmos. The method of dosage which they had arrived at was to use a Mueller tube, with an alternate spark-gap of five inches. He intended to keep it high so as to avoid superficial action on the skin. The current he passed through the tube was always *0.8* to *1* m. a. The exposures took place ten inches from the anti-cathode, and the duration was fifteen minutes. In all cases, the skin was protected with one to two layers (according to the condition of the tube) of ordinary lint, soaked in a saturated solution of tungstate of sodium. A separate piece could be used for every patient, as it is very cheap. He did not think he had had a single case of dermatitis in his department in the last four years, though thirty to forty cases had been treated daily, and some for months.

The Mueller tube, he said, is convenient, but a fault is that, while for the first two or three times, the vacuum could be regulated satisfactorily, subsequently, it lasted only a short time. He thought that the Osmo regulators were much better. Probably, the best device was the porcelain valve of Bauer; the vacuum seemed to be as permanent as the original exhaustion.

Drs. Pfahler and Thrusk, New York, report the case of a young woman, with the right gland enlarged for two months. She was cured after twenty-two exposures to the *x*-ray in two months. She gained twenty-one pounds in weight and the pulse fell from *120* to *72*. They collected thirty-one cases of goitre treated by this method, thus far. Four were exophthalmic. Twenty-eight showed improvement.

Görl treated seven cases with the x-ray and in all there was marked diminution in the size of the growth, as well as improvement in the other symptoms. Medium soft, or soft tubes were employed; and, at a comparatively short distance. In one case, the skin was unusually sensitive to the rays, and Görl suggests this condition may be one of the symptoms of the disease.

W. Ironside Bruce writes that the third and fourth cases were exophthalmic goitre, treated by exposure of each side of the neck to the *x*-ray tri-weekly. In the third case, the pulse, on November *21/06*, was *100*. By January *2/07*, it had fallen to *72*, and all other symptoms were improved, but the gland was not reduced in size.

In case *4*, the pulse rate on August *4/06*, was *112*. With similar treatment the pulse fell to *84* by January *18/07*, and all the other symptoms were markedly relieved.

The improvement in the general condition takes place apparently without reduction in the size of the gland or amelioration to any marked extent in the condition of the eyes.

Gottwald Schwartz treated forty cases with the *x*-ray. After three months there was marked lessening of nervous symptoms in all; diminishing of pulse rate in thirty-six; and diminution of the goitre in five.

Dr. George C. Johnston, writing of exophthalmic goitre, says that Mayo, when time will permit, submits his patients to a series of anti-operation radiations, and also makes use of the *x*-rays in treatment, considering that the rays exert a favorable effect on the over-activity of the gland in exophthalmic goitre. While its effect may not be permanent, he considers it a valuable adjunct in preparing advanced cases for surgical procedure.

The form of goitre peculiarly fitted for *x*-ray treatment is the exophthalmic. While but a slight hypertrophy of the gland may be present, yet the secretory function is exaggerated and the symptoms, tachycardia, tremor, etc., are largely toxic. The first effect of the *x*-ray is inhibition of function. Exophthalmic goitre has a high death rate. The death rate following operation is uncomfortably high. X-ray treatment is effective, and, when properly applied, has no death rate. The results are fully equal, if not superior to those obtained by operation. I believe it will not be necessary to operate on many of these cases if they are submitted to *x*-ray treatment, which should be continued for at least three months, for a fair trial. All varieties of goitre are suitable for *x*-ray treatment; the exophthalmic is the most suitable; the cystic, the least.

Technic.—Medium tube at ten inches, with a leather filter. Give two m.a. through the tube, for fifteen minutes daily, and, later, tri-weekly.

An illustrative case is cited of recovery from exophthalmic goitre, with pulse of *140* reduced to *90*. Two and one-half years later, the patient is in perfect condition.

In another case, taking treatment for tubercular adenitis a simple goitre disappeared and has remained cured for four years.

In a large goitre, without exophthalmos, treated three years previously, the results have been permanent and satisfactory, though the patient did not receive sufficient treatment to accomplish a cure.

In general, soft tumors are most amenable to treatment by *x*-rays, but they always exert a salutary influence on the nervous symptoms.

Leprince has treated five cases, with four recoveries, and in the fifth, the nervousness and tachycardia disappeared. The neck should be rayed anteriorly and laterally.

EXOPHTHALMIC GOITRE TREATED BY HIGH-FREQUENCY.

The following is an illustrative case under my care:

Miss —, aged *17*, consulted me on account of an enlargement of the neck. Eighteen months previously, it had begun to enlarge, but had increased very much in the last six months. She has exophthalmic goitre and is neuresthenic.

Under medical treatment the goitre had decreased from *17* to *14* inches and her health was much improved. The eyes are not now prominent. But the goitre has not lessened in the past three months. Pulse is *109* and the neck measures *14* inches below and *12.5* above.

I now used the high-frequency current for one month with a vacuum electrode applied to the neck, while her hands grasped the couch electrodes. The neck did not decrease in circumference, but her health was improved.

Negative galvanism—seven m.a.—was then applied daily, for one month to the neck, when it was reduced to *13.5* inches below and *11.5* above.

The neck was then treated daily for three months with the sinusoidal current, after which, it measured *13* inches below and *11.5* above; this being normal.

Dr. T. A. Pease uses high-frequency and also uses the galvanic current, with adrenalin on the positive pole. A four per cent solution on the copper electrode is applied to the gland until the skin is thoroughly bleached. He then applies the high-frequency current, with a wooden electrode with an intense vibration produced by means of a sprig transformer. This method had given him better results than any other.

High-Frequency and X-ray.—Vassilideo considers exophthalmic goitre a disease of the great sympathetic nerve, and thinks both *x*-ray and high-frequency currents should be used.

The treatment should be tri-weekly or fifteen to twenty treatments monthly. In order not to cause too severe reaction the high-frequency effluve should be applied for two minutes between each irradiation. Further, before each *x*-ray treatment, the patient is given general high-frequency treatment on the auto-condensation couch. To ensure recovery, Vassilideo considers that from sixty to eighty treatments are required, varying in time, from some months to two years.

EXOPHTHALMIC GOITRE TREATED BY GALVANISM.

Newman cured three cases with the employment of the galvanic current.

1. —, aged *40*; neuresthenic; pulse *120* to *150*; neck thirteen and one-sixth inches. Her relatives were alarmed in regard to her life. The negative electrode, with two to ten m.a. of current was applied for ten minutes to the thyroid. Galvanization to the head and solar plexus.

In four months the neck was normal; the eyes not protuberant; pulse *76*; temperature *98.50°*. No nervousness: well.

2. A less severe case was nearly well in nine months, under similar treatment.

3. A young girl was treated medically for years and grew worse. Her mother had Basedow's disease.

Recovery in four months by the use of galvanism five times weekly.

Valude says: "Apply a galvanic current, with the positive pole, eight to ten c.m. long, parallel to the anterior margin of the sterno-mastoid muscle, the whole length of the cervical sympathetic; a large negative electrode on the nape of the neck, with fifteen to twenty m.a. of current for fifteen to twenty minutes. Good results may be obtained as regards the exophthalmos; the tachycardia and the nervous symptoms."

Leprince says that the negative electrode, four inches square, is placed upon the goitre, the positive electrode upon the nucha. With thirty m.a. for twenty minutes, the effect is very rapid.

Faradization.—Leprince writes that the Vigouroux method is to apply the current to the carotid, the eye, the goitre and the cardiac region. The positive pole is applied to the vertebræ and the negative to each side of the carotid for one and one-half minutes. The electrode is then placed upon the lids; and, later, the electrode, four c. m. in diameter, is placed upon the thyroid, immediately above the sternum, for two to three minutes. The positive pole is next placed in the third intercostal space with a feeble current, for two to three minutes.

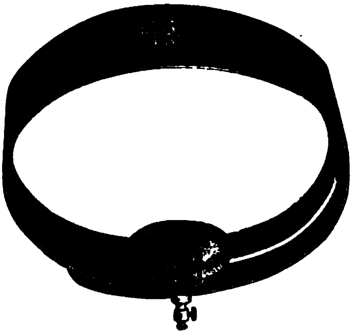


Fig. 152.—Neck Electrode.

EXOPHTHALMIC GOITRE TREATED WITH THE *500* C. P. LAMP.

Rogers says that the treatment of goitre by the *500* c. p. lamp applies to the simple hypertrophic, the fibroid, the follicular, and the exophthalmic, at certain stages of its development, in which the heat rays should be applied locally for fifteen minutes daily, and when a general tonic is indicated, for the whole body. The results, in these cases, have been uniformly good, and a large number of cases have been cured. In the cystic, colloid and amyloid degenerations, the results have not been encouraging.

I, personally, have noticed that after applying the lamp with considerable vigor, so as to produce a decided dermatitis, the cases have done better than with more moderate exposure.

Treatment by Electrolysis.

Vaudey, of Marseilles, recommends electrolysis as a successful way of treating this disease. He advises steel needles, insulated by the surgeon just before the operation, by dipping them in a solution of shellac, one part to five parts of alcohol—to within one-fifth of the point.

He reports excellent results upon the general health of the patient and upon the enlarged gland.

GOITRE.

Dr. Charles R. Dickson, of Toronto, Canada, treats goitre with the galvanic current, and says that the cases which are, probably, the most favorable for treatment are those of simple vascular engorgement of recent origin. For the positive electrode he uses the Goelet clay pad between the shoulders. For the negative, a thinner clay pad which should cover all the tumor. The first application is fifteen to twenty m.a. for ten minutes. Grdaually increase the strength, later, to one hundred and twenty m.a. or less. Dr. Dickson considers a strong current for a short time preferable to a weaker one for a longer period.

When the tumor is distinctly fibrous and has resisted the external method, he says that puncture may be resorted to. For the negative, he uses either surgeons' needles or longer ones made of piano wire. He prefers to puncture through the isthmus, if possible, and from as low down as possible.

Technic.—Direct the patient to swallow several times during the introduction of the needles and to support the growth with the disengaged hand to avoid puncture of the larynx or trachea. The first time, give a current of ten m.a. for ten minutes; but, afterwards, once a week, *50* m. a. may be reached. The external treatment may be applied at intervals of the punctures.

Cystic.—Dr. Dickson says, that in the cystic form, with the negative pole, is connected an aspirating needle, insulated to the desired length, and the bare end introduced well within the sac. The contents are aspirated and the sac filled to distension with a solution of chloride of sodium, one drachm to one ounce. With the positive large pad in position, fifty m. a. are gradually turned on for twenty minutes and then the fluid reaspirated.

Morton, of New York, says that simple goitre, before hyperplasia takes place, may be invariably cured by a few administrations of the wave current, applied to the glands. For general treatment, apply an electrode to the epigastrium.

Cataphoresis.—Scheppegrell, in the cataphoric application of iodine has found a saturated solution of iodide of potassium to be more useful than the tincture; also, since iodine ions seek the positive pole, that it should be applied to the negative electrode instead of the positive. The iodine, being liberated in a nascent state, is more efficacious than the free iodine of the tincture.

CHAPTER V.

PERSONAL COMMUNICATIONS.

ELECTRICAL TREATMENT OF THE EAR, NOSE AND THROAT.

A personal communication from Dr. Joseph C. Beck, of Chicago.

Case *1*. Mr. S., aged *43*. The usual history of a *Chronic Lacunar Tonsilitis,* with marked plethora and arteriosclerosis, and a history of considerable bleeding following the extraction of a tooth, some six months ago.

An actual cautery dissection was decided upon and performed under local infiltration anesthesia. With fairly heavy cautery knives and the heat a degree more than cherry red, the right tonsil was completely removed by firmly drawing the tonsil, by means of a vulsellum forceps, out of its bed, and very slowly severing its attachment with this heated knife, as one would do with an ordinary knife. The bleeding at the time of the operation was about the same as when using the cold method, except at the base. Here in both tonsils was a marked difference, being much less. No snare was employed. The reaction following was considerable, but not more than some of the cases show after the ordinary dissection methods.

However, in the few cases that I have employed this method, several years ago, it seemed to me that the secondary reaction was greater than in the cold methods. I should say that in selected cases, as this one was, this, the Pynchon method of cautery dissection, has a distinct place in the field of tonsil surgery. Pynchon was the first to my knowledge, who intentionally performed a tonsillectomy, although he did it in two or more sittings at first; later advising the complete operation at once. The result in this particular case was very good.

Case *2*. Miss C., aged *18*. Usual history of repeated attack of acute tonsilitis, with very *Large Chronic Hypertrophic Tonsils.* She refuses operation. Under locally applied anæsthesia, twenty per cent cocaine, by means of long and obliquely bent cautery points, heated to a cherry-red, both tonsils were cauterized in about fifteen different points on the cryptic face of the gland. The opening of the crypt itself was avoided so as not to seal it up. The point was, after being heated, allowed to sink into the tonsil its full length (one-quarter inch). This procedure was repeated, only not as many points, as soon as the reaction disappeared. In this way was the tonsil reduced in size, and the disease, while not brought to a complete standstill, was reduced to one or two attacks a year, whereas she had had several in a year previously.

Case *3*. Mr. R., aged *30*. Diagnosis: *Sarcoma of the Tonsil.* After loosening its attachments to the pillars and surrounding structures, a snare wire which fits into an electrode handle is placed about the entire tonsillar tumor and drawn taut, the current turned on and gradually increased until it burns through all the tissues, while the snare is tightened. Thus the bleeding is minimized.

Case *4*. Mrs. G., aged *43*. Diagnosis: *Post-Nasal Fibroma,* filling the entire post-nasal space. A number seven piano wire, attached to an electric cautery snare is placed snugly about the base of the tumor and the current turned on. This outlines the attachment. Very rapidly, with a thin sharp instrument, the margins of the tumor are undermined so as to enable the snare wire to get a good hold and not slip off as easily as it would otherwise. Gradually draw down the wire and turn on the current to a fairly marked degree, because the severance must be accomplished very rapidly, on account of the bleeding. A post-nasal tampon should always be in readiness on this account.

Case 6. Mr. H. Diagnosis: *Chronic Hypertrophy of the Inferior Turbinated Body.* Cocainization of a small anterior area. Thrust into the most prominent portion of the turbinate the electrolytic needle, which is attached to the negative pole, while the positive sponge electrode is placed on any indifferent portions of the body. A current of ten m. a. is allowed to pass into the tissues for five minutes. One will observe the hydrogen bubbles at the hilt of the needle. Apply a tampon, saturated in ichthyol and glycerine, ten per cent, for about an hour, following the treatment. Such electrolytic seances are often repeated two or three times, with intervals of one month.

Case 7. Mrs. A. Diagnosis: *Marked Angiomatous Hypertrophy of the Posterior Ends of the Inferior Turbinated Bodies.* Pass the loop of an electric cautery snare over the posterior end by the aid of the finger in the post-nasal space, and verify by the post-rhinoscopic mirror. Draw taut the wire, turn on the current and increase gradually until it has cut through.

Case 8. Mr. K. Diagnosis: *Chronic Recurrent Bleeding Ulcer of the Cartilaginous Septum.* Cocainization of the area, with twenty per cent solution. By means of a ball-shaped platinum electrode, sear the surface down to the cartilage. If bleeding takes place, during the seance, then apply adrenalin tampon for a few moments and reapply the cautery to this particular bleeder. Fill the nostril with either vaseline or a mixture (bismuth paste, No. 2) of bismuth subnitrate, thirty parts; white wax, five parts; paraffin, five parts, and vaseline, sixty parts.

This same technic of cautery applies to tuberculous, luetic or other ulcerative areas of the septum.

Case *9*. Master J. C., *4* years old. Diagnosis, by means of a radiogram: *Foreign Body in the Left Bronchus*...By means of a Brüning's electrically lighted bronchoscope the foreign body is located, and, with a suitable forceps and blunt hooks, is removed. The operation was performed under general chloroform anaesthesia.

Case *10*. Miss L., aged *14*. Diagnosis, by means of a radiogram: *Twenty-Five Cent Piece in the Esophagus*. Under local anesthesia, by means of a Jackson's electric lighted esophagoscope, the coin was removed by a long grasping (alligator) forceps. The technic of the passage of the laryngo- tracheo-broncho- esophago-gastroscope is not within the scope of this brief description; and the writer would refer the reader to the text-books of Jackson, Brüning and Manus on this subject.

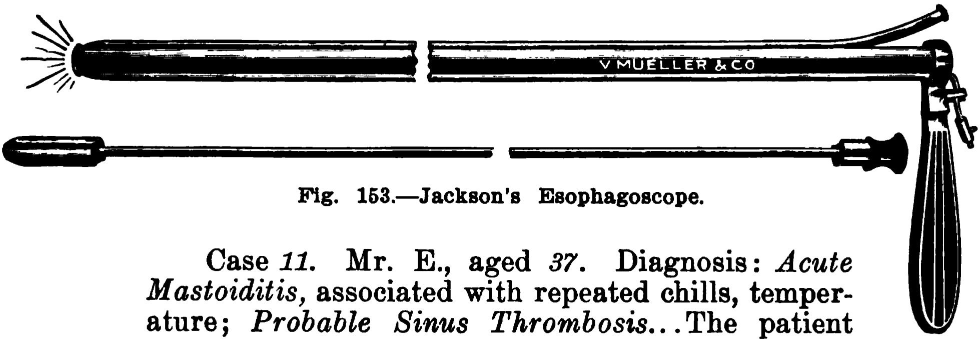


Fig. 153.—Jackson's Esophagoscope.

Case *11*. Mr. E., aged *37*. Diagnosis: *Acute Mastoiditis*, associated with repeated chills, temperature; *Probable Sinus Thrombosis*...The patient was in no shape for general anaesthesia, consequently was operated under local infiltration anaesthetic, and the entire cleaning out of the mastoid cells, including the removal of the cortex by means of a motor drill. It is the most thorough, rapid and least uncomfortable method for the patient known and gives most excellent results.

Case *12*. Miss M., aged *46*. Ever since childhood, she has had a *Chronic Suppuration of the Middle Ear,* and the *x*-ray picture reveals a sclerosed mastoid. Operation. Radical mastoid. The greatest portion of the sclerosed mastoid bone was removed by means of the electric bur. This procedure facilitates the operation, shortens the same, and healing is much more rapid than when other methods are employed.

Case *13*. Miss C. Diagnosis: *Chronic Tubal Catarrh With a Secondary Adhesive Inflammation of the Middle Ear.* Hearing: R. E. = *10/20*. L. E. = *4/20*.

By the aid of Hay's pharyngoscope, the eustachian orifices were inspected, as also by the aid of the Holmes' naso-pharyngoscope. Through a eustachian catheter a gold bougie was passed as far as and beyond the isthmus. This bougie is connected with the negative side of the battery, while the positive sponge electrode is held in the patient's hand. A current of five to ten m. a. is passed through the bougie for five minutes three times a week. The movements of the tympanic membranes are brought about by means of a pneumo-massage pump, worked by a motor, for three to five minutes twice weekly. To further influence the noises, a glass electrode of a high-frequency current is passed into the external auditory canal and allowed to remain about two minutes, twice weekly.

After one year, the hearing in R. E. = *10/20*; in L. E. = *8/20*. The ability to hear conversation has much improved and the tinnitus has become much less. An hour after each treatment, the tinnitus became less and remained so till the next treatment.

PERSONAL EXPERIENCES IN THE USE OF ELECTRICITY.

A personal communication from Dr. Otto J. Stein, of Chicago.

The use of electricity in my hands of late years has been employed in two different groups of cases. In the first group, it is employed as an aid to diagnosis or an adjunct to the application of the treatment. In the second group, it is used simply as a therapeutic agent. The former group includes the transillumination of the nasal accessory sinuses and of the ear. Its value, used in this manner, cannot be disclaimed and it has now become a "routine" in the examination of patients. At the same time, it may prove useless if the principles of its use are not fully understood. The variability in the density and thickness of the bones of the face and head have always to be considered. The intensity of the

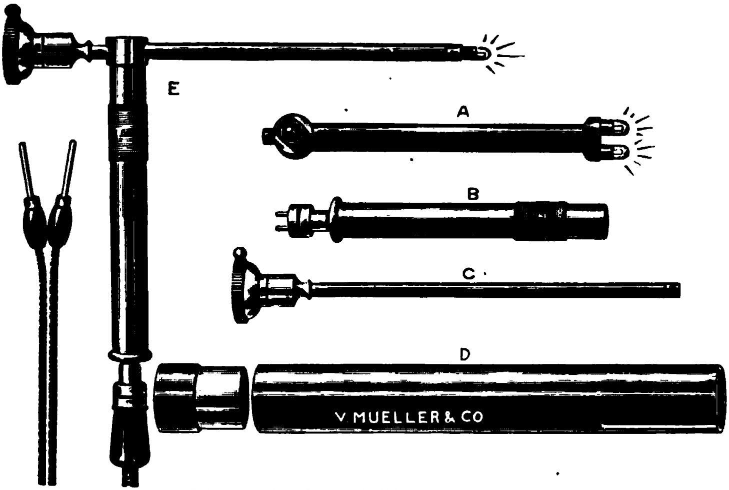


Fig. 154.—Hays' Pharyngoscope.

illumination must be regulated, for a powerful light may penetrate very thick or dense tissue and even fluid like pus or cyst contents, while, on the other hand, a feeble light may not illumine even perfectly normal parts.

The illumination by various instruments that have been so ingeniously devised of late, for the examination of the various cavities of the head, chest and abdomen, has marked a real advance in instrumentation and proved a great boon to the physician and patient.

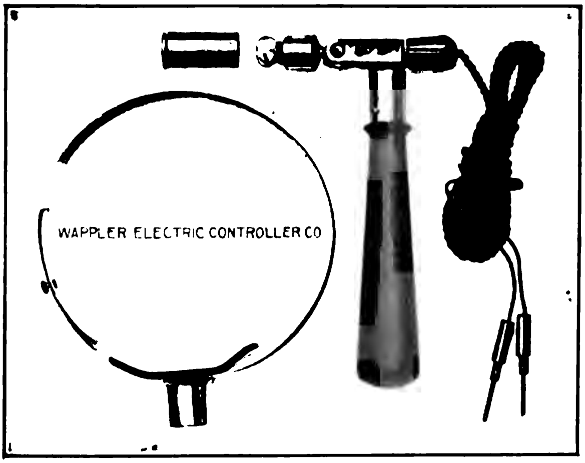


Fig. 155.—Transilluminator and Head Lamp.

The pharyngoscope and salpingoscope are both of great value for the examination and even treatment of the nasopharynx, with its tubal orifices, and the laryngopharynx.

The electric headlight is well known now and is used by almost all physicians, but especially by the specialist. The Klaar, Kirstein, Freeman, De-Zeng, Stucky and Mueller headlights furnish a variety sufficient for the most exacting examination and use in operating. I find the neat and compact little pocket case, containing a small dry cell, an admirable aid to the examination of the ears, nose and throat at the bedside.

One of the greatest advancements made in late years is the electric illumination of the tracheoscope, bronchoscope, esophagoscope and gastroscope for the examination and treatment of the various regions under direct inspection. In the Jackson and Ingalls instruments, the tiny lamp is carried at the distal end of the instrument, while, in the Bruening and Kahler, the lamp is placed at the proximal end, and the light is then reflected by mirror.

Additional instruments of this kind have been devised by Mosher, Johnstone, Yankauer and others, all of which I have found excellent and useful in a variety of cases.

The use of electric power for running vibrator and suction apparatus and for driving burs, drills and trephines is in common use, but, personally, I have discontinued its use, because it is not always so reliable, also, it requires more complicated and expensive apparatus. In its place, I now use compressed air with great success.

For the treatment of chronic deafness, especially of the dry catarrhal variety, I consider the vibrator of Meyer a useful instrument. Four dry cells are employed to energize an armature that causes a hammer to strike a mica diaphragm, creating a uniform noise of low pitch and graded intensity.

The *x*-ray, for the treatment of some affections of the head, like leukoplakia, malignancy, chronic ulcers and leukemia, and also for making skiagraphs for diagnostic purposes, to facilitate locating foreign bodies, determining the size and shape of the sinuses, also the presence of fractures, has proven of some benefit to me, although both fall far short of what I would desire.

The galvanic and faradic currents are still used with benefit in stimulating the functional activity of the muscles of face and throat.

The cataphoric application of electricity is good and such remedies as copper, iodine and strychine may be used in this manner with some benefit.

The galvano-cautery still remains with me a most useful means of treatment. In the intumescent form of chronic rhinitis, I elect its employment over all other methods of treatment, if not contra-indicated. I prefer the deep linear cauterization of the lower turbinate, keeping away from the extreme posterior end to avoid an acute otitis media. The knife-like electrode is applied to the lower third of the turbinate, which is the most enlarged, and the electrode is allowed to sink down through the soft tissues and rub upon the periostium. In this manner of application, I find the most lasting and beneficial results can be procured.

Of late, the employment of fulguration has been showing some good results, especially in its application to tuberculous conditions of the larynx.

THE DIRECT CURRENT IN DISEASES OF THE EAR AND THROAT.

Dr. Otto Freer, of Chicago, in a personal communication, writes:

I have had a long experience in the use of the constant current in the treatment of chronic, inflammatory conditions of the ear and upper air passages. While of little or no use in atrophic catarrh, its influence in causing absorption of chronic inflammatory hyperplasias is marked and reliable, round celled infiltration disappearing or lessening.

Chronic Tubal Swelling and Obstructions.—I treat this by filling the external auditory meatus with wet absorbent cotton, applying to this a sponge electrode as the negative pole. The positive pole is a Eustachian catheter, insulated by painting it with flexible collodion, and covered at its distal end with absorbent cotton. The cotton is dipped in a protargol solution, 30 grains to the ounce of water, and applied by means of the catheter to the ostium tubae, but not passed into its lumen. The current strength is five m. a., the time five minutes. The protargol is carried cataphorically into the mucosa.

In suitable cases, the effect is marked. Obstinate tubal obstruction of a hyperplastic nature and seated near the pharyngeal orifice of the tube promptly disappears. Cicatricial strictures are, of course, uninfluenced.

Chronic Hyperplastic Laryngitis.—I have had also striking results from the treatment of chronic hyperplastic laryngitis by internal galvanism, a cotton covered laryngeal electrode, dipped in the above protargol solution, being attached to the positive pole, while the negative pole is applied to the front of the larynx as a sponge electrode.

The larynx is previously thoroughly cocainized by swabbing it with cocaine flake crystals, used pure, on a moistened swab. The current strength is ten to thirty m.a.; the time, one to three minutes.

In obstinate cases of laryngitis, I have also had good results from galvanization of the larynx. A sponge is applied externally to the thyroid cartilage, with a current of ten to twenty m.a. for five minutes.

THE ELECTRICAL TREATMENT OF THE EAR, NOSE AND THROAT.

As Dr. R. A. Boyd, of Chicago, has, for the past fifteen years, in an extensive practice in ear, nose and throat, devoted himself almost exclusively to electrical treatment, with an ever-increasing confidence in its efficacy, I am happy to be able to offer my readers a personal communication, in which Dr. Boyd describes his methods and indicates in some slight degree his successes.

Oto-sclerosis.—I have found, says Dr. Boyd, the most satisfactory apparatus for use in the treatment of oto-sclerosis to be that designed for the sinusoidal current only, in which the current and speed are separately controlled by two graphite rheostats. I apply the sponge pads of a binaural electrode to the pinnae, and use an amount of current which the patient can comfortably tolerate, for five minutes daily. It requires from two to four weeks to determine the probability of benefit. About sixty per cent of my patients are improved by a course of treatment which usually continues for three months. The tinnitus lessens as the hearing increases.

To instance one illustrative case, which is now under my care:

A girl of eighteen years was treated by an aurist, with Politzerization, for two years, without improvement. When she consulted me, ten days ago, I found that the malleus was invisible, that the patient could hear the tuning-fork, *225*, at two inches only, and conversation poorly at two feet. I treated her, as described above, for ten days, after which she heard the fork at eighteen inches and conversation at five feet. The malleus is plainly visible.

The patient is still in attendance.

My preference for the sinusoidal current in cases of this character is the result of personal experience. Some fifteen years ago, I was employing the direct current, with the electrodes applied in the same manner as described. In a year's experience, I failed to improve the hearing except in one instance, in which I had operated upon a turbinate. This operation might be accountable for the improvement.

The Nose.—When the turbinates and septum are both involved I first treat the septum.

Electrolysis of Septal Ridges or Spurs.—My technic is: First apply a *20* per cent solution of quinine and urea, on a pledget of cotton, to the septum and change the cotton every fifteen minutes for forty-five to sixty minutes. The solution is non-toxic, and, in some persons, acts as a stimulant.

I use a bipolar needle, one-half to three-quarter inches long, with a current of ten to twenty m. a. for ten to twenty minutes, according to the nature of the tissue.

At the completion of the operation, the tissues should appear of an ash-gray color and be contracted to normal size.

This treatment is successful in bony as well as in cartilaginous ridges, but, in the former case, the needles should be as large as the lead of an ordinary pencil. They should be inserted below the surface of the growth to a depth of twice the diameter of the needle. I never have any difficulty in introducing the needles into bony ridges.

One treatment usually suffices; occasionally two, and very rarely three are required. The only inconvenience is a very slight discharge for three or four weeks after a turbinal operation and for ten days subsequent to a septal operation.

Turbinates.—Enlarged turbinates I treat by electrolysis, in the same manner as described for septal operations, except that I utilize finer needles. In nearly all cases of otosclerosis, I find it necessary to treat the turbinates.

Stricture of the Eustachian Tube.—This condition I treat with the direct current, placing a negative electrode in the tube and using four to five m. a. of current for two minutes, and I generally repeat this about six times. This usually results in patency of the tube and improved hearing.

I find that the sinusoidal current, as used in otosclerosis also relieves stricture of the tube.

So convinced am I of the value of the sinusoidal current, that I would now feel it impossible to continue ear practice without its aid.

Hypertrophy of the Tonsils.—Inject into the tonsil, a hypodermic syringeful of 20 per cent solution of quinine and urea; and, five minutes later, introduce a bipolar needle with a current of fifteen m. a. for twenty minutes. One treatment suffices to reduce the tonsil to normal size.

Adenoids.—Swab the throat with a 5 per cent solution of cocaine; and, five minutes later, use the direct current, with a hemispherical electrode of copper, one-quarter of an inch in diameter, applying the rounded surface and moving it from side to side over the adenoids, using a current of four m. a. for three to four minutes. I have found one treatment sufficient and as successful as curetting. Children do not resent the treatment, and, two days after, they breathe freely.

Pharyngitis and Laryngitis.—I use the sinusoidal current externally for five minutes daily. This relieves the hoarseness and other symptoms promptly.

Goitre.—I have used the sinusoidal current very successfully. In one case of two and a half years' and one of two years' standing, with the gland as large as an orange and without exophthalmos, I reduced the glands, in six weeks' daily treatment, to almost normal. The patients, aged 28 and 32, consulted me chiefly on account of the deformity and not on account of unpleasant symptoms.

A REPORT OF SOME CASES UNDER ELECTRICAL TREATMENT DURING THE PAST MONTH.

As the book goes to print, it occurs to me that it is of interest to add a chapter giving a brief resume of the interesting cases under my care during the past month, as they contribute additional testimony to the immense value of electrical modalities.

July, *1912*. Recovery from a double Acute Conjunctivitis, with abrasion of the corneal epithelium, by eight applications of the *500* c. p. lamp.

E. H., aged *9*, referred by Dr. Anderson, who had skilfully prescribed *5 %* argyrol, every second hour. After one week's treatment, there was little relief of the pain and other symptoms, and the child was sent to me.

The little lad is very pale and in delicate health. The *500* c. p. lamp was applied for one half-hour daily, for eight days, when recovery was complete and the patient was referred to Dr. Anderson for general treatment.

EYELASHES.

The length of the ciliae doubled in four weeks by the sinusoidal current.

Miss B., aged *20*, had a mild blepharitis marginalis, with fine thinly scattered lashes, *2* m. m. in length.

Treatment with the sinusoidal current, applied to the lids for twenty minutes tri-weekly for four weeks, increased their size so much as to give a compact row of lashes. The blepharitis disappeared.

TRACHOMA.

A case of chronic trachoma, with pannus, which recovered under high-frequency fulguration to the lids and eyeballs, with vision improved from *1/5* to *2/3* in the right eye and from *1/7* to *2/3* in the left.

J. W., aged *22*. Two years ago he attended the Eye and Ear Infirmary on account of granular lids, of seven years standing. He was treated tri-weekly, for nine months, with cupri sulph. Last summer, he returned to the Infirmary and had further treatment.

His condition when he came under my care was as follows: The lids droop and twitch and the eyes feel very uncomfortable. The palpebral conjunctiva is very red and *velvety* and slightly scarred. The upper third of each cornea shows many fine superficial vessels when examined by a triplex magnifier.

Treatment consisted of the application of the high-frequency current by means of a glass vacuum pharyngeal electrode directly to the eye, without cocainization. The short rectangular tip of the electrode was placed under the upper lid and the end on the eyeball and moved from side to side, using a mild effluve. This was done tri-weekly, for two minutes, to each eye.

In ten weeks, the eyes were comfortable, the conjunctiva smooth, and the cornea nearly non-vascular.

IRITIS.

A complete recovery from iritis, after four treatments with phototherapy, without the use of any local or general medication.

I had treated this patient for a previous attack of iritis with the *500* c. p. lamp, atropin and mercury, securing an unprecedently rapid recovery, and deemed it justifiable to try the *lamp only* in this second attack, as I believe the effect of atropin is only mechanical; its beneficial effect being limited to the prevention of synechia.

The patient T. N., came with an iritis of the right eye of a week's standing. There had been severe pain for two days, keeping him awake at night. The eye was very red, the pupil small and inactive and the iris discolored.

Wasserman test negative. Vision = *20/20*.

The pain was immediately and permanently relieved after the first exposure of the eye to the *500* c. p. lamp for half an hour. After four daily treatments, of one half-hour each, the eye completely recovered.

CATARACT.

A case of incipient senile cataract completely recovered under treatment with the direct current.

Mrs. H., aged *71*, referred to me by Dr. R. D. Boyd, came to the office Jan. *29/12*, during my vacation and was examined by my associate, Dr. Long, who reported that Mrs. H. complains of pain in the eyes and head; that she is in poor health, being nervous and sleepless. The vision of right eye, with + *3.00* is *20/50*; of left eye *20/25*. There are eight to ten fine striae on the temporal side of the left lens.

On February *28*th, Mrs. H. returned, when I examined her, finding the left lens as described by Dr Long. The right pupil was not dilated for examination.

I advised the treatment of K. I. and Hg. for a time, then, if there should be no improvement, or if an improvement should cease, to have electrical treatment.

Under K. I. and Hg. the vision improved, by March *9*th, in the right eye to *20/40*, but decreased to *20/33* in the left. The treatment was continued until March *31*st, when R. E. = *20/33*, L. E. = *20/33*.

Electricity was then prescribed.

The direct current to the lids, with *2.50* m. a. for twenty minutes daily was given until May 1, when vision stood: R. E. = *20/33*, L. E. = *20/20 — 1.* Treatment for ten minutes daily on the auto-condensation couch was given coincidently.

Both the general treatment on the couch and the direct current to the eyes were continued until June *7*th, when the vision in right eye was *20/25*; in left, *20/20.*

The left lens, under a dilated pupil, shows no trace of striae, as confirmed by Dr. Long. The right eye was not dilated for examination.

Mrs. H. remarked that her health had not been so good in years and that the pain in the eyes had almost completely disappeared.

The sphygmographic tracings, before and after treatment are shown in Fig. *156* and corroborated the benefit of the treatment by the auto-condensation couch.

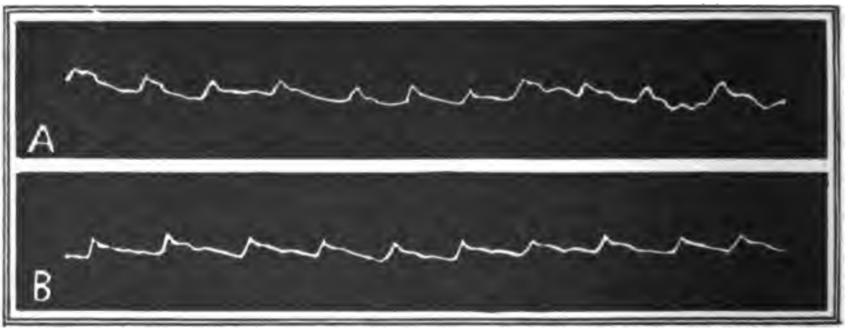


Fig. 156.—Sphygmographic Tracings.—A. May 1st, 1912. B. May 31st, 1912.

SENILE CATARACT.

Vision improved in one eye by the direct current. Mrs. S. W., aged *82.* When she consulted me, there were several striae in the right eye, with one opaque plaque in the lens and a few floating opaque bodies in the vitreous. The vision of the right eye was *20/50.*

In the left lens there was one radiating line and an opaque plaque. Very numerous, small white disc shaped bodies, probably phosphates, danced about in the vitreous. Synchysis. The vision of the left eye was *10/100.*

I applied the direct current, *2.50* m. a. to the lids for fifteen minutes daily.

After twenty-five treatments, vision rose in the right eye to *20/40.* In the left eye, the vision remained *10/100.* The treatment was continued for six weeks, when the vision in right eye dropped to *20/50*; the left remaining *10/100.*

July *3/12.* At the close of another twenty-five days' treatment, the vision of right eye has risen to *20/40*; the left remaining *10/100.*

With synchysis of the left eye, no improvement could be expected.

HYALITIS.

In the following case of double acute hyalitis, the right eye recovered under K. I., while the vision of the left eye first improved, then deteriorated.

The sinusoidal current then improved the left eye from *1/70* to *1/5.*

Mrs. I., aged *25,* has voluminous dust opacities in each vitreous. R. E. vision = *20/30.* L. E. = *4/100.*

In binocular fixation, at six inches, the left eye diverges. No positive history of lues, but the patient had received *606.* Under K. I., for two months, the vitreous of each eye became quite clear; the vision of the right eye normal, of the left *10/200.*

This low vision was probably due to amblyopia exanopsia.

Two weeks later, the vision of the left eye was reduced to *3/200*, when the iodide was suspended and electricity submitted. The sinusoidal current was given daily, for twenty minutes, during twelve days, when vision increased *14* times in the left eye.

ALTERNATING CONVERGING STRABISMUS.

In a case of alternating converging strabismus, with high refractive error, the vision is doubled by the application of the sinusoidal current.

C. B., aged *6*, has had strabismus since two years of age. With refractive correction, the vision of the right eye is *1/12*; of the left eye, *1/3*. The eyes soon became parallel with the glasses on; but when off, the right strongly converges.

Following twenty electrical treatments, the vision is doubled in each eye.

TURBINATES.

A comparative test of cauterization and electrolysis of the turbinate, in the same patient.

Miss F., aged *24*, consulted me August *28/11*.

History. — She has had so much nasal discharge for the past year that she has used ten handkerchiefs a day, and she contracts frequent colds because she cannot breathe freely.

Both inferior turbinates touch the septum.

On that day the whole length of the left turbinate was cauterized to the bone, in one sitting.

Three weeks later the nasal discharge had ceased; the breathing was much freer; the turbinate was reduced *25* per cent. in size, but nearly touched the septum.

I then treated the other turbinate with electrolysis. A ten per cent. solution of quinine and urea was applied to the turbinate with four applicators (cotton), during one half-hour. My bipolar needles, made one and one-quarter inches long, were introduced into the longtitudinal centre of the turbinate and left in for fifteen minutes, with a current of fifteen m. a. Upon withdrawing the needles, the points were found to be in contact, which lessened much the effective current.

Nine weeks later, the right turbinate was reduced one-half. Bipolar electrolysis, with fifteen m. a. for fifteen minutes was repeated.

Six months later the right turbinal was normal in size; the left touched the septum.

I now used the bipolar needle on the left side, with fifteen m. a. for fifteen minutes.

One week later, the left turbinate is normal in size, the breathing is normal, and there is no nasal discharge.

ACUTE ACNE.

A recent acne on the nose disappeared in one week, after three mild fulgurations, of thirty seconds each.

Incidentally, a deep fissure on the palmar surface of a finger joint,—of eighteen years' duration,—which had resisted the efforts of many physicians to heal it, succumbed to thirty seconds of fulguration.

MOLE.

A twelve years old mole, the size of half a small pea, situated on the nose, yielded to one application of metallic fulguration, for one minute.

At the same time, a depressed scar on the face was much lessened by a single one-minute fulguration.

Glaucoma is in so large a percentage of cases associated with high blood pressure and has been so much ameliorated by general electrization with the auto-condensation couch, that the following incident is of importance to the oculist.

A patient, who was under treatment, was incidentally placed upon the auto-condensation couch, for twenty minutes daily, to determine the effect upon his blood pressure. During the previous two years the blood pressure had, upon repeated examinations been found to be *160*, which was normal for his age. His health was exceptionally good.

It is interesting to note that in four weeks his blood pressure was reduced to *125*.

LIST OF AUTHORS

Abadie, *281, 301.*
Ahlborn, M. B., *528.*
Alleman, *214, 245, 254, 261.*
Allen, C. E., *529.*
Allen, C. W., *505.*
Allport, F., *444.*
Althaus, *96, 490.*
Anderson, S. T., *270, 329.*
Anderson, Willis S., *479.*
Andrews, Albert H., *428, 436, 488.*
Arcolio, *237, 309, 342, 352.*
Aysaguer, *500.*

Ball, *250, 344.*
Baker, Albert, *288.*
Ballinger, W., *417, 422. 454, 478, 488, 505, 521, 525, 527, 528.*
Ballin, M. J., *500.*
Barclay, Robert, *407.*
Barr, Thomas, *415.*
Battesti, *229.*
Bayer, *465.*
Beard and Rockwell, *109.*
Beaver, B. D. B., *256.*
Beck, Joseph C., *509, 561.*
Beclere, *351.*
Becqueral, *95.*
Benedict, *344.*
Bergonie, *502.*
Bergonie and Maure, *489.*
Bernard, Claude, *109.*
Bie, *140.*
Billinkin, *394.*
Birkett, H. S., *504.*
Bishop, Francis B., *377.*
Bishop, Seth, S., *475, 490, 510.*
Black, Melville G., *334, 479.*
Bloch, *121.*
Boettcher, *443.*
Bonlay, M., *539.*
Bordier, *128, 379.*
Bosc, *379.*
Bosworth, *497.*
Boucheron, *308, 323.*
Boyd, R. A., *573.*
Briere, *37, 230.*
Briggs, J. R., *488.*
Bristow, A. T., *379.*
Brooks, E. D., *427.*
Brown, Heman, *240.*
Brown, Moreau, R., *417.*
Browne, Lennox, *525, 526.*
Bruce, W. Ironside, *557.*
Bryant, *408.*
Bull, *344.*
Burch, John, *349.*
Burdick, Gordon G., *178, 291.*

Calmette, *461.*
Campbell, John F., *310.*
Casselberry, W. E., *486*
Cerara, Luis, *201.*
Chiari, O., *535.*
Cleaves, Margaret., *188.*
Colburn, J. Elliott, *270.*
Collins, Treacher, *252.*
Cook, Finley R., *162, 457, 517.*
Coover, *326.*
Copart, *464.*
Cornwall, F., *235.*
Crocker, H. B., *422.*
Crussel, Gustav, *243, 266.*
Curtis, H. Holbrook, *489.*

Darier, *228, 274, 304, 325.*
D'Arsonval, *336.*
Davey, Byron, *173.*
Davis, J. H., *214.*
DeBlois, F. A., *474, 529.*
DeGrandmont, Gillet, *301, 304. 321.*
Dench, *409.*
Derby, Haskett, *299.*
DeRenzi, *538.*
DeSchweinitz, *334, 369, 376.*
DeTymouski, *519, 525.*
Devereaux, *539.*
Dickson, A., *222.*
Dickson, Charles R., *171, 458. 562.*
Dieudonne, *139.*
Dixon, *143.*
Dor, *323.*
Dorman, Albert B., *141.*
Draispul, *466, 504, 519, 528.*
Driver, *324.*
Duel, A. B., *420.*

Eberhart, *413.*
Egger, L., *454.*
Erb, *88, 258, 324, 344.*
Eulenberg, *351.*
Everts, *291.*

Fellows, C. Gurnee, *399.*
Ferran, *425.*
Finkelpearl, H., *188.*
Fisher, W. A., *284, 286.*
Fiske, George, F., *408.*
Flatau, *48z.*
Fletcher, J. R., *542.*
Fox, L. Webster, *298, 306, 379, 385.*
Freer, Otto, *460, 572.*
Freudenthal, W., *537, 548.*

Garel, *527, 531.*
George, *402.*
Geyser, Albert, C., *159, 223, 387*
Gleitsman, *477.*
Goldstein, Samuel, *465.*
Gongora, L., *498.*
Gonzales, *330.*
Goodale, J. L., *476.*
Gorl, *557.*

Gradle, H. S., 234, 368.
Graefe, 266.
Green, J. Jr., 375, 395.
Groenbeck, 527.
Groh, 528.
Grubbe, Emil H., 120, 176.
Grunwald, 525.
Gunn, 299.

Haab, 285.
Hamilton, D. H., 521.
Haret, 351.
Harper, J. E., 378.
Harris, Samuel, J., 267, 363, 421.
Hawley, Clark W., 235.
Helbing, 460.
Hennebert, 454.
Henriques, Adolph, 114.
Hertel, 140.
Heryng, 539.
Hilgartner, 310.
Hirschberg, 295.
Hohler, Alban, 160.
Holland, C. Thurston, 552.
Holmes, E. M., 523.
Hopkins, C. W., 424.
Hubert, 249.
Hughes, C. H., 185.
Huizinga, J. G., 231, 232.
Hurd, L. M., 539.

Iglauer, Samuel, 440.
Imbert, 330.
Ingals, E. Fletcher, 471, 475, 497, 498, 529.

Jackson, W. L., 461.
Jessup, 227.
Johnston, George C., 557.
Jones, H. Lewis, 191.
Jouslain, 464.

Kaarsburg, 499, 500, 502.
Keating-Hart, 372,
Kellogg, J. H., 90, 143.
Kerrison, Pilip D., 416.
Killian, 465, 546.
Kine, J. W., 138.
King, W. H., 392, 532, 534.
Kipp, 285.
Knapp, 250, 285.
Knight, Charles, 475.
Kniskern, E. L., 277.

Laffe, 351.
Lang, W., 293.
Larat, 243.
Laurens, 541.
Law, F. M., 454.
Leduc, 252, 349, 466.
Lefferts, John M., 498.
Leonard, C. L., 375.
Leplat, 379.
Leprince, 201, 225, 229, 249, 259, 299, 327, 346, 357, 359, 370.

Lichtwitz, L., 461, 529.
Lincoln, R., 500.
Little, 277, 299.
Logan, J. E., 501.
Long, Charles H., 467.
Loring, 90.
Lucae, A., 408.
Lucrezio, Tommaso, 462.
Lundsguard, 212.
Lyon, Howard N., 396.

Macintyre, John, 375.
Maclay, Otis H., 474.
Marage, 431.
Marcus, 408.
Marques, 330.
Martin, 353.
Marvin, A. H., 521.
Massey, G. Betton, 186, 520.
Massucci, 534.
Matlack, Ellwood, 423.
Mathewson, A., 242.
Mayou, M. S., 219, 375.
McBride, 464.
McEwen, W., 440.
McIntosh, Herbert, 135.
McMarple, Wilbur P., 368.
Mermod 538.
Meyer, E., 489.
Mial, L. L., 227.
Miot, 461.
Monell, 102.
Mortimer, W. G., 243.
Morton, W. J., 104, 183, 221, 379, 430, 527, 563.

Neftel, 266.
Neiswanger, C. S., 376, 459.
Neris, F. E., 485.
Newcomb, J. E., 490.
Newcomer, 375.
Newman, Robert, 98, 560.
Nieden, 237.
Neuman, 243, 265.

Ostmann, 415.
Oudin, 371, 395.

Packard, 415.
Parasotti, 242, 358.
Pardo, 254.
Parker, Charles A., 518.
Pease, T. A., 559.
Pensier, 213, 247, 308, 342, 359, 503.
Pfahler, 556.
Phillips, Wendell C., 422, 452.
Pieniazek, 541.
Pierce, Norval H., 476.
Politzer, 414.
Pusey, W. Allen, 148, 375.
Pynchon, Edwin, 476, 519, 520.

Quadei, 351.

Ramsden, 211.
Reich, 407.

Reuss, *300.*
Rice, Clarence C., *461, 463.*
Rice, M. C., *374.*
Riddell, J. R., *391, 412.*
Rieder, H., *158.*
Ring, *375.*
Riviere, J. A., *116.*
Roger, A. S., *440.*
Rogers, C. E., *129, 211, 253, 274, 328, 352, 425, 502, 527, 535, 550, 556.*
Romiee, *358.*
Roosa, St. J. B., *90.*
Rosenberg, Julius, *135, 458.*
Roure, *330.*
Rousseau, L., *526.*

Sajous, C. E., *498.*
Schamberg, Jay Frank, *139.*
Schauffler, W. G., *541.*
Scheppegrell, W., *101, 126, 185, 461, 464, 474, 481, 497, 510, 511, 518, 534, 535, 536, 540.*
Schloss, A., *430.*
Schmidt, Moritz, *486.*
Schmidt-Rimpler, *290.*
Schmithnisen, W., *526, 537.*
Schultze, Kurt, *115.*
Schwartz, Gottwald, *557.*
Seiss, R. W., *464, 525.*
Semon, Felix, *541.*
Skinner, E. H., *524.*
Snow, W. Benham, *164, 183, 335.*
Snydacker, E. F., *239.*
Sommerbrodt, Julius, *460.*
Soule, Isaac C., *506.*
St, Clair, R. W., *499.*
Standish, Miles, *299.*
Starkey, Horace, *213.*
Stein, Otto J., *569.*
Stephenson, Sidney, *168, 212.*
Stern, Samuel, *174.*
Stover, G. H., *178, 378.*
Strazza, *498.*
Strong, F. Finch, *115.*
Sulzer, *229; 248.*
Sweet, W. M., *289, 292, 376.*

Taylor, *463.*
Terry, M. D., *500.*
Terson, *301.*
Teulon, Giraud, *260, 277, 342.*
Thomas, Homer M., *478.*
Thompson, Silvanus, *7.*
Thrusk, *556.*
Tice, F. C., *551.*
Tousey, Sinclair, *382, 537.*
Tousseau, *374.*
Traquaire, *238.*
Treadwell, Charles H., *105.*
True, *330.*

Urbantschitsch, *414.*
Usiglio, *249, 265.*

Valude, *560.*
Vassilideo, *560.*
Vaudey, *562.*
Veasey, C. A., *334.*
Villard, *379.*
Vineta, *331.*
Vietek, *349.*
Voltolini, *454, 501.*
VonJansen, *139.*

Walker, Holford, *273.*
Weisflog, *231.*
Wetherbee, W. B., *178.*
Wheatland, M. F., *102.*
Williams, P. Watson, *485.*
Wingrave, *534.*
Wirtz, *231.*
Wright, S. St. John, *182.*
Wurdemann, H. V., *90, 310, 319.*
Yankauer, Sidney, *460, 551.*
Yonge, Eugene S., *530.*

Zanoga, *324.*
Ziegler, S. Lewis, *281, 325, 331.*
Zitowitsch, *416.*

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GENERAL INDEX

Acoommodation, paralysis of, *342*.
Acne of the nose, *457, 583*.
    Mibonian, high-frequency current in, *394*.
    Mibonion with light therapy, *458*.
Acne rosacea, *458*.
Adenoids, *526, 576*.
    fulguration discharges in, *393*
Alopecia of the lids, *200*.
Alternating current, *39*.
    generator, *37*.
Ambloypia, alcohol and tobacco, *356*.
    congenital, *353*.
    exanopsia, *355*.
    exanopsia,, high frequency current in, *386*.
    hysterical, *358*.
    of high refractive error, *353*.
    strabismic, *353*.
Anaesthesia, *185*.
    electro-cocain, *185*.
    traumatic, *308*.
Angioma, *204, 527*.
    of the mouth, *500*.
    of the nose, *498, 504*.
    of the tonsil, *521*.
Angio-sarcoma of the septum, *504*.
Anosmia, *466*.
Antral disease, treated with ozone, *512*.
Aphonia, hysterical, *534*.
Arteriosclerosis, ocular manifestations of, *334, 367*.
    d'Arsonvalization, in treatment of, *335, 337*.
Asthenopia, *341*.
    accommodative, *339*.
    muscular, *342*.
Astigmatism, *367*.
Atrophy, optic, *312*.
    optic, high-frequency current in, *387*.
    tabetic, *324*.
Auditory canal, stricture of, *407*.
Audophone, The, *435*.
Author's equipment, *81*.
Auto-condensation couch, *111*.
Automatic cut-outs, *68*.

Batteries, *14*.
Birthmarks, *204*.
Blastomecytis, *204, 206*.
Blepharitis marginalis, *197, 379*.
    high-frequency current in, *386, 403*.
Blepharospasm, *201*.
Blood pressure, an index to, *334*.
    reduction of, *584*.
Blue light, *256*.
    results obtained from, *141*.
    effect of, on bacteria, *139*.
Bougie, the electric, *422*.
Bronchorrhoea, *547*.
Bronchoscopy, *542*.

Caldwell Cavity Tube, *171*.
Cancer, high-frequency current in treatment of, *392*.
    treatment of by cataphoric sterilization, *186*.
Carcinoma of right vocal chord, *380*.
Cataphoresis, *100*.
    in suppuration of the middle ear, *427*.
Catarrh, chronic, of the nose, *388*.
    chronic tubal, *568, 572*.
    vernal, *212*.
Cataract, *265, 579*.
Cells, joined in multiple parallel, *22*.
    joined in parallel, *20*.
    joined in series, *20*.
Cellulitis, orbital, *380*.
Cervical enlargements, *500*.
Chalazion, *214*.
    fulguration discharges in, *394*
Choroid, the, *255*.
Choroiditis, *263*.
    atrophic, *309*.
    X-Ray in, *400*.
Chorio-retinitis, *309*.
Cicatricial contractions, *422*.
Coil, voltage of the, *53*.
Condenser, the, *53*.
Conjunctiva, The, *197*.
    Tuberculosis of the palpebral, *212*.
Conjunctivitis, acute, catarrhal, *207, 577*.
    chronic palpebral, *209*.
    follicular, *394*.
    high-frequency current in, *394*
    phlyctenular, *210*.
    phototherapy in, *170*.
Copiopia, *351*.
Cornea, The, *229*.
    fistula of, *235*.
    ulcer of, *234, 237*.
    ulcer serpent, of, *241*.
    ulcer of high-frequency current in, *386*.
    ulcer of leucodescent light for, *402*.
    radiotherapy in, *400*.
Current, *16*.
    alternating, *39*.
    conduction of a, *22*.
    electric, *87*.
    faradic, *30*.
    galvanic, *14, 92*.
    high-frequency, *53*.

Dacryocystitis, *228*.
    chronic suppurative, *234*.
Dacryocstoblennorrhoea, *227*.

Deafness, chronic, 411.
  compressed air heater in, 424
  an aid in, 435.
Dermatitis, 149.
Descemetitis, 403.
Diathermancy, 45.
Diphtheria, 539.
Direct current, 15.
  application and therapeutic effect of, 92.
  characteristics of, 87.
  duration of, 89.
  effect of, on the eye, 90.
  in diseases of the ear and throat, 572.
  polarity of, 89.
  strength of, 89.
Disc, choked, 328.
Distichiasis, 198.
Dynamo and battery, what do they supply? 19.

Ear, electricity in diseases of the, 405.
  chronic suppuration of the middle, 568.
  growths in the, 454.
  sinusoidal current in sclerosis of middle, 402.
Ectropion, 200.
Eczema, 202.
  high-frequency current in, 394
Effluve, effect of, 114.
Electricity ,therapeutic use of, 86.
  in minor surgical affections of the eye, 396.
  static, therapeutics of, 105.
Electric lamp, therapeutic use of, 134.
Electric light, in diseases of the respiratory organs, 548.
  in treatment of syphilis, 188.
  therapeutic properties of, 137
Electric ophthalmoscope, 368.
Electro-cautery, use in the nose, 467.
Electro-diagnosis in Eye disease, 382.
Electro-magnet, The, 12, 531.
Electro-motive force, 16.
Electrodes, condenser, effect of, 115
Electrolysis, 92 95, 397.
  and its therapeutical application, 98.
  laws of, 98.
  metallic, 104.
Electroscope, The, 533.
Electrophorus, The, 6
Entropion, 200.
Epiphora, 224.
Episcleritis, 251.
Epistaxis, 461.
Epithelioma, 370.
  cutis, 528.
  of the ear, 528.
  of the nose, 502, 528.
  of the throat, 528.
  of the tongue, 528.
  parenchymatous, 373.
  with X-Ray, 176.
Erythropsia, 300.
Eye, electricity in diseases of the, 197.
Eyeball, double perforation of the, 292.
Eyelashes, 577.
Eyelids 197.
Eustachian tube, the, 420.
  stricture of the, 575.
Exophthalmic goitre, 552.
  high-frequency current in, 388, 559.
  X-Ray in, 552.

Faraday ring, 32.
Faradic current, 30.
Faradic coil of the wall plate, 50.
Faradism, physiological effects of, 108.
Fibroid, post nasal, 499.
Fibroma of the pharynx, 527.
  post nasal, 565.
Fistula of the neck, 529.
Foreign body in the bronchus, 567
  in the eye, diagnosis of, 283.
  localization of, in the eye, 75.
  in the meatus, 454.
  in the oesophagus, 529, 544, 567.
Frictional electricity, 3.
Fulguration, 372.
  discharges, 392.
  of malignant tumors, 115.
Furuncles, 407.
Fuses, 68.

Galvanic current, application and therapeutic effect of, 92.
Galvanism, 14.
Galvano-cautery in nasal disease, 477.
  passing of the, 479.
Galvano-faradic wall plate, 49.
Galvanometers, 24.
Generator ,the multiplex, 60.
Glands, enlarged, 529.
Glaucoma, 329.
  acute, 330.
  chronic, 331.
  double, 333.
  hemorrhagic, 333.
  X-Ray in, 400.
Goitre, 562, 576.
  treatment of with cataphoresis, 563.
  cystic, 563.
  high-frequency current in, 477
Granular lids, high-frequency current in, 386.
Growths, non-malignant, 541.

Haemorrhage, intra-ocular, 278.
Hay-Fever and Asthma, 548.
Headache, ocular, 347.
Head noises, 431.

Heat, *42*.
  animal, *46*.
  distribution of, *44*.
  influence of the source of, on transmission, *45*.
  laws of radiation of, *44*.
  radiant, *44*, *143*.
  sources of, *46*.
  transmission of, *43*.
Hemeralopia, *353*.
Herpes ophthalmicus, *203*, *242*.
High-frequency current, *53*.
  action of, on cell life, *370*.
  dosage of,
  in diseases of nose and throat, *506*.
  in malignant diseases of eye, *370*.
  in medicine, *120*.
  in ophthalmic practice, *385*.
  physiological effect of, *111*.
Hordeolum, *198*.
Hyalitis, acute, *281*, *581*.
Hypermetropia, *353*.

Indolent patches, *526*.
Interrupter, *55*.
  Mercury turbine, *55*.
  Wehnelt's electrolytic, *56*.
Iodine, diffusion of, by electric current, *102*.
Ionotherapy, *258*.
Irido-cyclitis, *259*.
Iris and ciliary body, *255*, *258*.
  haemorrhage from the, *261*.
Iritis, *255*, *380*, *385*.
  blue light in, *141*.
  high-frequency current in, *386*, *391*.
  phototherapy in, *578*.
  recurrent rheumatic, Minim light in, *142*.
  serous, *258*.
  sequalae of specific relapsing, *257*.
  with hypopion, *258*.

Keratitis, hereditary syphilitic, *231*
  herpetic, *242*.
  hypopion, *231*.
  interstitial vascular, *231*.
  neuro-paralytic, *232*.
  parenchymatosa, *230*.
  tubercular, *232*.
  ulcerative, *237*, *241*.
  xerotic, *232*.
Keratoconus, *250*.
Krohmeyer's lamp, *203*.

Labyrinth disease, *452*.
  diagnosis of, by electrical stimulation, *448*.
Lachrymal apparatus, *197*.
  fistula, *228*.
  gland, *224*.
  passages, *225*.
Lamp, arc, *131*.
  electric, therapeutic use of the, *134*.
  Finsen, *132*.
  incandescent, *133*.
  Krohmeyer's, *203*.
  open arc, *133*.
  therapeutic, *130*.
Larynx, bilateral adductor paralysis of, *535*.
  cancer of, *540*.
  electrolysis, in treatment of, *538*.
  galvano-cautery, in treatment of, *536*, *537*.
  malignant diseases of the, *540*
  neuroses of, *534*.
  paralysis of, *534*.
  stenosis of the, *539*.
  tuberculosis of the, *537*, *542*.
Laryngitis, acute, *535*, *576*.
  chronic, *508*.
  high-frequency current in, *508*
  pachydermia, *573*.
Laryngeal, papillomata, *535*.
Lens, The crystalline, *265*.
Leucoma, *243*.
Leukoplacia of the cheek and tongue, *529*.
Lingual varix, *528*.
Lipoma of the nose, *499*.
Light, *41*.
  blue, *141*.
  chemical properties of, *128*.
  effect of, on bacteria, *139*.
  penetration of, *129*.
  physical properties of, *127*.
  refrangibility of, *42*.
  as a remedial agent, *138*.
  solar, *137*.
  therapeutics of, *135*.
Localizer, Sweet's, *75*.
Lupus, *174*, *375*, *379*, *393*, *503*, *541*.
  erythematosa, *376*.
  tuberculous, *376*.

Magnetism, *10*.
  Induction of, *12*.
  theory of, *13*.
Magnetic field, *13*.
  aciton of magnetic lines on the, *38*.
Magnet, the electro, *12*.
  the induction of currents by, *34*.
  operations, *285*.
Malignant diseases of the eye, *368*
Malignant tumors, fulguration of, *115*.
Massage, electrical, in errors of refraction, *363*.
  mechanical, in treatment of nose, throat and ear, *417*.

Mastoid, The, *436*.
  antrum, choice of instruments for opening, *441*.
  operation, use of bur in, *440*.
  transillumination of the, *436*.
  treated by phototherapy, *437*.
  X-Ray examination an aid in diagnosis, *440*.
Mastoiditis, *567*.
Membrana tympani, *417*.
Microbes, *114*.
Moles, *375*, *458*, *583*.
Morton Wave, *117*.
  Dr. Neiswanger's modification of, *105*.
Mothers' marks, *204*.
Motors, *71*.
Multiplex generator, *59*.
Muscles, the ocular, *339*.
  paralysis of the external ocular, *343*.
  sinusoidal current in treatment of, *402*.
Myalgia, high-frequency current in treatment of, *388*.
Mycosis of larynx, *539*.
  of tonsil, *522*.
Myopia, *354*, *367*.
  high, *355*.
Myosis, *260*.
Myxomata, simple, *498*.

Naevus vascularis, *203*, *204*.
  electrical methods in treatment, *191*.
  high-frequency in treatment of *375*, *388*, *390*.
Nasal growths, electro-cautery in, *497*.
Nasal hydrorrhoea, *460*.
Nasal mucosa, *465*.
  polypoid degeneration of, *466*
Neuralgia, facial, *348*.
  convulsive, *351*.
  morton wave in treatment of, *403*.
  supra-orbital, *348*.
  X-Ray, in treatment of, *350*.
Neuritis, *391*.
  high-frequency in treatment of, *388*, *391*.
  intra-ocular optic, *328*.
Neuroses, reflex of nasal origin, *460*.
Nose, dilated veins of the external, *460*.
  electricity, in diseases of, *455*
  frost bitten, *460*.
  high-frequency current in chronic catarrh of, *388*.
Nystagmus, *448*.

Oesophagoscope, *530*.
Oesophagoscopy, *542*.
Oesophagus, foreign body in, *567*.
  removal of foreign body from, by aid of X-Ray, *529*.
  stricture of the, *532*.
Ohm's law, *18*.
Opacities in the vitreous, *275*.
Ophthalmia gonorrhoeal, *211*.
  neonatorum, *211*.
Ophthalmo-diaphanoscope, *368*.
Opthalmoscope, an improved electric, *368*.
Optic atrophy, *312*.
  high-frequency current in treatment of, *387*.
Optic nerve, *312*.
Optic neuritis, *328*.
  high--frequency current in treatment of, *387*, *391*.
Orbicularis, paralysis of the, *202*.
Orbit, epithelioma of the, *379*.
  sarcoma of the, *379*.
  vascular tumors of the, *380*.
Orbital cellulitis, *380*.
Otalgia, *417*.
Otitis media, atrophic, *428*.
  chronic non-suppurative, *409*.
  chronic suppurative, treated with ozone, *513*.
  use of 500 c. p. lamp in acute, catarrhal, suppurative, *425*, *427*.
Otology, hot air in, *425*.
Otosclerosis, *416*, *574*.
  sound waves in treatment of, *432*.
Oudin d'Arsonval resonator, *54*, *369*.
Ozena, *462*.
Ozone, in medicine, *182*.
  its production and use, *179*.
  in treatment of accessory sinuses, *511*.

Pachydermia laryngis, *535*.
Pannus, *229*.
Papillomata of the nose and larynx, *500*.
Paralysis, bilateral abductor, *534*.
  of eye muscles, *343*.
  of throat muscles, *526*.
Personal communications, *396*, *564* *569*, *572*.
Pharyngitis acute catarrhal, *576*.
  follicular, *525*.
  granular, *525*.
  hyperplastica, *525*.
Pharynx, *523*.
  diesases of the, *525*.
  examination of, by aid of naso-pharyngoscope, *523*.
  tertiary syphilitic ulceration of, *526*.
Phonograph, use of, in testing hearing, *408*.
Phonographic acoumeter, *408*.
Phonometer, a new, *408*.
Phototherapy, *127*, *168*.
  in tuberculosis of the conjunctiva, *212*.
Physics, elementary, of electricity, *1*.
Pneumo-massage, *363*.
  in deafness, *415*.
Polypi, *526*.

Port wine marks, 390, 502.
Potential, difference of, 17.
Presbyopia, 368.
Protective devices, 68.
Pterygium tenuis, 213.

Radiating power of a body, 44.
Radiotherapy, 168.
Rectifiers, 68.
  alternating current, 71.
  electrolytic, 69.
  five cell, 72.
  rotary, 69.
Refraction, electricity in errors of, 363.
Resistance, 16.
Resistance box, 29.
Resonator, Oudin d'Arsonval, 54.
Retina, cysticercus of, 304.
  detachment of, 301.
  diseases of the, 297.
  glioma of the, 310.
  radiotherapy, in inflammation of the, 401.
Retinal anaesthesia, 306.
  embolism, 305.
  haemorrhage, 303, 310, 386.
  thrombosis, 304.
Retinitis albuminuria, 306.
  diabetic, 304.
  haemorrhagic, 309, 380.
  neuro-syphilitic, 308.
  pigmentosa, 297.
  high-frequency current in treatment of, 386.
  proliferans, 386.
Rheostats, 26, 64.
  carbon, 64.
  coil, 26.
  compression, 64.
  water, 64.
  wire, 64.
Rheotome, 28, 53.
Rhinitis, acute and subacute, 461.
  atrophic, 506.
  chronic, 506.
  chorio, 309.
  electrolysis, in treatment of, 480.
  high-frequency current in treatment of, 506.
  hypertrophic, 462, 473.
  purulent, 461.
  spasmodic, 461.
Rhino-scleroma, with X-Ray, 500.
Rhumkorff coil, 53.
Roentgen rays in therapeutics and diagnosis, 148.

Sarcoma, 170, 378.
  of orbit, 379.
  of tonsil, 520, 565.
Scars, high-frequency current in treatment of, 392.
Scar tissue, treatment of, 459.
Sclera, 229.
Scleritis, 251.
Sclero-choroiditis, anterior, 261.
Sclerosis of middle ear, 402.
Septal operations, 489, 495.
  bipolar method in, 493.
  monopolar method in, 491.
  ridges and spurs, electrolysis of, 575.
Septum, angio-sarcoma of, 504.
  bleeding ulcer of cartilaginous, 566.
  nasal, the, 486.
  reduction of spurs on, 486.
Sine curves, 60.
Sinus disease, transillumination in diagnosis of, 564.
  X-Ray in diagnosis of, 565.
Sinuses, the accessory, 509.
  ozone, in treatment of suppurative, 511.
Sinusitis maxillary, treatment by ozone, 512.
Sinusoidal apparatus, 57.
  current, 39.
  effect of, on nerves of special sense, 123.
  is it electrolytic? 122.
  the therapeutic effect of the, 122.
Skin diseases, comparison of treatment of, 505.
Snaring, 485.
Spectrum, 127.
Spring catarrh, 170.
Static electricity, physics of, 2.
  therapeutics of, 105.
  machine, 7.
  coil, versus the, 113.
Strabismus, 582.
Sunlight, thermal analysis of, 45.

Telsa apparatus, 107.
Throat, electricity in diseases of the, 515.
Tinnitus aurium, 413, 430.
Tonsils, electro-cautery in treatment of, 518.
  high-frequency in treatment of, 517.
  hypertrophied, 565, 576.
  hyperkeratosis of the, 521.
  mycosis of the, 522.
  sarcoma of the, 520, 565.
  treatment of, with electrolysis, 518.
  tumors of the, 520.
'Tonsillitis acute, high-frequency in treatment of, 387, 507.
  lacunar and follicular, 564.
Tonsillotomy by electro-cautery dissection, 519.
Toxins, 114.
Tracheitis, 541.
Trachoma, 170, 214.
  fulguration, in treatment of, 394.
  high-frequency current in treatment of, 387, 578.
  X-Ray, in treatment of, 400.

Transformer, *57.*
  alternating current, *34.*
  direct current, *34.*
  step down, *57.*
  step up, *32, 33, 57.*
Transillumination, *63.*
Trephine, the, *479.*
Tubercular glands, *174.*
Tumor, naso-pharyngeal, *500.*
  non-malignant, of nose and throat, *498.*
  varicose, *498.*
Turbinates, the, *467, 471, 582.*
  electrolysis of, *483, 575.*
  hypertrophy of the, *478, 566.*

Ulcer, chronic, *377.*
  of cornea, *377.*
  rodent, *378, 393.*
Ultra-violet rays, *129.*
Uvula, elongated, *529.*
Velum paleti, paresis of, *529.*
Vibrassage, *419.*
Vibratory massage in deafness, *415*
Vitreous, the, *275.*
  inflammation of, radiotherapy in, *401.*
  opacities in the, *275.*
  high - frequency current in treatment of, *387, 390.*
Voltage, *15, 16.*
  of the coil, *53.*
Voltaic turbinal puncture, *485.*
Voltaic vertigo, *537.*
Voltmeters, *24.*
Volt selecter, *65.*

Wall plate, faradic coil of the, *50.*
  galvano-faradic, *49.*
Warts, *375.*
  high - frequency current in treatment of, *388.*
Water, *65.*
Wood alcohol blindness, *325.*

Xantelasma, *206, 379.*
X-Ray, the, *47, 145.*
  after operation, *178.*
  anodyne effect of, *151.*
  compared with other forms of radiant energy, *164.*
  cumulative effects of, *149.*
  deep seated effects of, *149.*
  effects of, *167.*
  effect on bacteria, *151.*
  effect on tissues, *148.*
  flashes, *162, 400.*
  frequency of exposure, *154.*
  in external diseases of the eye, *395.*
  in medicine and surgery, *173.*
  indication for therapeutic use, *158.*
  influence on tuberculosis, *152.*
  in malignant diseases of the eye, *370.*
  possibilities of, in diagnosis, *524.*
  protectives from, *157.*
  smaller doses of, *158.*
  technic of the application of, *145.*
  tehcnic of X-Ray exposure, *148, 158.*
  theory of the production of, *48*
  treatment by, *174.*
  tubes, *147, 155.*